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How the Foundry Industry Has Prepared for War

By Promptly Meeting Rapidly Changing Economic Requirements Foundrymen Have Kept Their Houses in Order and Are Prepared

Prosperity in Midst of Many Crises Proves Valuable Experience to Foundrymen

PREPARED for any eventuality! That is the answer of the American foundry industry to Uncle Sam's call for aid in the present crisis. Casting manufacturers have been in training for 2½ years to meet such a contingency as exists at present. They have prepared, consciously or otherwise. They have been compelled to cope with strained situations imposed by labor, readjustments due to advancing raw material markets and demands for product greatly in excess of the capacities of their plants. They have successfully coped with the ever-changing conditions and their houses are in order. Plant extensions have been made unstintingly to meet immediate rather than future needs, labor-saving equipment has been installed and efficiency systems have been adopted that place the foundry trade in the front rank of America's prepared industries.

This state of preparedness, however, has not been achieved without great sacrifice. Labor scarcity and insistent and continuous demands for higher wages developed many crises that had to be met. Increasing costs of raw materials had to be adjusted to low priced contracts. Deferred deliveries of equipment retarded much needed improvements, yet each situation has been faced successfully and every problem has been satisfactorily solved.

The foundry industry will now be weighed in the balance, but will not be found wanting.

But, as Howard E. Coffin so aptly put it, "We need prosperity in war time even more than when we are at peace." Casting manufacturers today are enjoying the greatest era of prosperity in the history of the country. Order books filled to overflowing are the best answer to any query regarding a threatened depression.

"Now is the time to open the throttle," says Mr. Coffin. It is wide open in every casting plant. Full steam is on and every casting shop is operating at full capacity. Advancing raw materials reflect the pressing demand. The government expenditures alone will more than compensate for any evil effects arising from a temporary hysteria following the declaration of war. And the raw material markets are the luminous sentinels that have and will continue to light the way for American casting manufacturers. Therefore, a resume of war conditions involving violent price changes, may foreshadow and safeguard the future.

THAT iron and steel, more than men, are the factors which make possible the conduct of wars is indicated by the meteoric rise of foundry iron prices from July, 1914, to the present time. The average quotations of all foundry grades have practically trebled, scrap prices have nearly doubled and Connellsville coke has advanced 400 to 500 per cent. To the foundryman who has been accustomed to figure upon a fraction of a cent increase in the cost of his iron, these advances in a period of less than three years have compelled him to change entirely the basis of his computations. The accompanying chart graphically shows the movement of all grades of foundry iron since July, 1914, to April, 1917, and in the accompanying table are given the average price variations from month to month. It will be noted that for a period of more than a year, namely from July, 1914, to August, 1915, prices remained almost stationary with the exception of a slight decline during the closing months of 1914, immediately following the declaration of war. The first eight months of last year witnessed no sharp price changes, but it became apparent in the last quarter of the year that in 1917 the production of pig iron would be insufficient to meet the requirements and since October and in a period of only seven months, prices have been practically doubled. During the month of April nearly all grades were marked up and there is every indication that further advances will be made. Low phosphorus pig iron has been sold as high as $75 per ton and $100 per ton is predicted. Lake Superior charcoal iron now is on a $40 basis and

"Open the Throttle," Says Howard E. Coffin

"We need prosperity in war time even more than when we are at peace. Business depressions always are bad but doubly so when we have a fight on our hands. The declaration of war can have no real evil effect on business. What bad effects are apparent are purely psychologic and largely of our own foolish making, for our markets are the same in April that they were in March. We need more business, not less. There is real danger in hysteria. Indiscriminate economy will be ruinous. Now is the time to open the throttle."

numerous sales of No. 2 foundry iron at this price have been reported.

One of the peculiar features of the foundry iron situation is the fact that scrap has not moved upward in line with foundry pig iron prices. Since July, 1914, quotations have doubled, whereas pig iron prices have been increased threefold. For practically a year after war was declared scrap was a drug on the market, although in the closing months of 1915 the demands for this material began to increase and while prices remained fairly steady throughout 1916, the advance since the first of the year has been marked and has been more in line with the increased quotations on pig metal. At the beginning of the war cast scrap was quoted in Chicago at $9.65 per ton, as compared with $19.50 per ton today and at Philadelphia in gross ton lots it was held at $12 in the summer of 1914, against $24.75 for the month of April. Malleable scrap at Chicago sold at an average price of $9 per ton in July, 1914, whereas malleable scrap is held at $20 today.

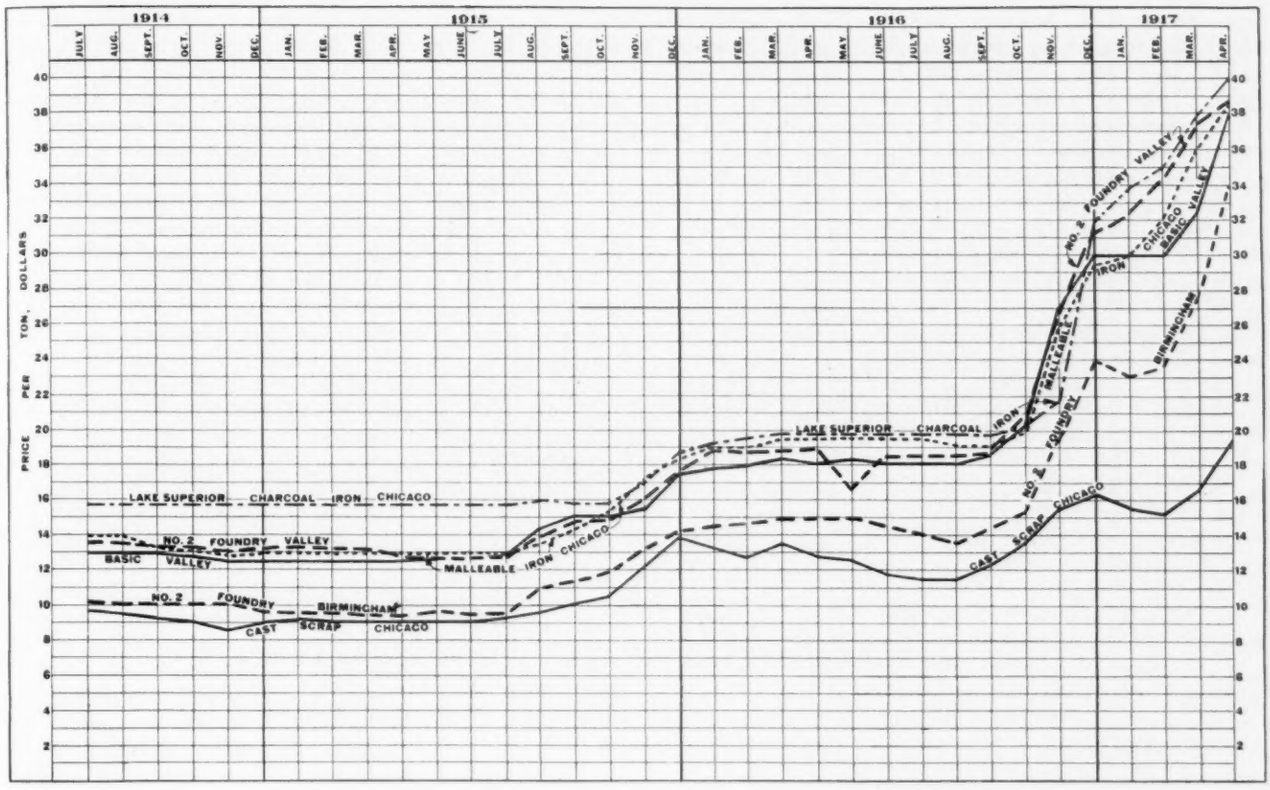
Let Our Washington Office Serve You

Washington today is the center of the nation's activity, both political and industrial. In this mad rush of preparation our Capital city is the mecca toward which all eyes are turned. Foundrymen unaccustomed to dealing with the government, who are figuring on munition and other work, are being called upon to submit their propositions in person. For many years, the Penton Publishing Co., publisher of *The Foundry*, has maintained an office in Washington in charge of L. W. Moffett, one of its associate editors. This office is at the disposal of every foundryman in America as his headquarters while in Washington. Mr. Moffett will extend you every courtesy and will aid you on your mission. Any communications addressed to him will receive immediate attention. The office is located at 708 Metropolitan Bank building, in the heart of the business district. Incidentally, this is the only office in Washington separately maintained by a publisher of trade and technical papers and in charge of an associate editor to whom has been extended the courtesies of the Press Galleries of the senate and the house.

Probably the most spectacular performance during this war period was staged by ferro-manganese, which truly can be said to be a *war bride* in every sense of the word. Steel founders, who are compelled to use this material, and gray iron foundrymen who buy it in small lots, must carefully figure upon this addition, which now involves the investment of a considerable sum. With foreign shipments practically cut off and the demand for this material increased, the unusual rise in its value is not surprising. Just prior to the declaration of war in 1914, the average during the month of July was $37.54, but when an embargo was declared the following month by England, the average price increased to $102.08. A sharp decline followed the temporary lifting of this embargo, although prices steadily advanced thereafter until the closing months of the following year saw an average of more than $100 per ton. In 1916 ferro-manganese staged some wonderful acrobatic feats and in April of last year sales were made at more than $400 per ton. From that high point prices gradually declined until November, when $165 was reached, but since that time there has been a steady advance and small sales were made last month on the basis of nearly

Average Monthly Prices of Foundry Iron, Machinery and Malleable Scrap, Ferro-Manganese and Coke Since the Declaration of the European War

	No. 2 Foundry, Iron, Valley, gross ton.	No. 2 Foundry Iron, Chicago, gross ton.	No. 2 Foundry Iron, Birmingham, gross ton.	Malleable Iron, Chicago, gross ton.	Lake Superior Charcoal Iron, Chicago, gross ton.	Low Phosphorus Iron, Philadelphia, gross ton.	Basic Iron, Valley, gross ton.	Ferro-manganese, gross ton.	Connellsville Fdy. Coke at ovens, net ton.	Cast scrap, Chicago, net ton.	Cast scrap, Philadelphia, gross ton.	Malleable scrap, Chicago, net ton.
1914.												
July	$13.50	$14.00	$10.15	$14.00	$15.75	$20.50	$13.00	$37.54	$2.27	$9.65	$12.00	$9.00
August	13.30	14.00	10.00	14.00	15.75	20.75	13.00	102.08	2.21	9.50	12.00	8.88
September	13.25	13.63	10.00	13.25	15.75	21.00	13.00	39.45	2.09	9.19	12.00	8.25
October	13.08	13.30	10.00	13.00	15.75	20.90	12.85	70.08	2.00	9.00	11.40	7.90
November	12.88	13.00	10.00	12.88	15.75	20.12	12.48	67.84	1.92	8.56	11.00	7.75
December	13.07	13.00	9.65	12.90	15.75	20.00	12.50	68.00	1.94	9.00	11.30	7.95
1915.												
January	13.25	13.00	9.50	13.00	15.75	20.00	12.50	68.00	2.00	9.19	12.00	8.13
February	13.25	13.00	9.50	13.00	15.75	20.00	12.50	78.80	2.00	9.00	12.00	8.00
March	13.25	13.00	9.38	13.00	15.75	20.00	12.50	95.00	2.00	9.00	12.00	7.94
April	12.95	13.00	9.35	13.00	15.75	20.00	12.50	95.00	2.00	9.00	11.75	8.00
May	12.75	13.00	9.73	13.00	15.75	20.00	12.65	97.00	2.00	9.00	12.13	8.14
June	12.75	13.00	9.56	13.00	15.75	20.60	12.72	105.11	2.00	9.00	12.25	8.13
July	12.86	13.00	9.60	13.00	15.75	21.37	12.96	103.57	2.00	9.25	12.38	8.90
August	13.94	13.38	11.00	13.44	16.00	22.12	14.36	101.36	2.00	9.62	13.30	10.00
September	14.75	13.80	11.30	14.30	15.85	24.35	15.00	110.00	2.09	10.10	14.00	10.25
October	14.86	14.44	11.75	15.25	15.75	26.25	15.01	109.64	2.35	10.50	14.00	10.25
November	15.92	17.12	13.12	17.13	17.00	29.40	15.52	100.42	2.87	12.13	14.50	11.38
December	17.52	18.00	14.20	18.20	18.65	31.60	17.49	103.04	2.95	13.75	16.06	13.75
1916.												
January	18.92	18.50	14.50	19.00	19.20	32.00	17.83	139.88	3.75	13.31	17.00	13.81
February	18.75	18.50	14.63	19.00	19.50	32.00	17.98	215.13	3.75	12.81	17.00	13.33
March	18.77	18.70	15.00	19.40	19.75	32.00	18.25	334.75	3.60	13.45	17.00	13.95
April	18.88	19.00	15.00	19.50	19.75	33.75	18.00	412.50	3.87	12.88	17.88	13.89
May	16.69	19.00	15.00	19.50	19.75	34.00	18.16	347.73	3.13	12.56	17.50	13.44
June	18.50	19.00	14.45	19.50	19.75	33.50	18.00	244.88	3.00	11.75	16.50	11.73
July	18.50	19.00	14.00	19.50	19.75	33.25	18.00	198.75	3.00	11.50	16.00	11.63
August	18.50	19.00	13.60	19.00	19.75	34.00	18.00	173.18	3.05	11.50	16.00	11.25
September	18.65	18.65	14.38	19.00	19.75	34.25	18.63	167.67	3.25	12.13	16.00	11.50
October	20.75	19.15	15.13	19.88	20.35	38.00	20.31	165.00	4.38	13.50	16.15	12.38
November	26.07	25.00	19.60	25.80	21.95	46.00	27.23	165.00	9.00	15.55	18.50	16.00
December	31.30	30.00	24.00	29.50	31.75	51.00	30.00	170.00	9.25	16.25	20.75	18.00
1917.												
January	32.36	30.00	23.00	30.00	33.75	54.00	30.00	169.00	10.35	15.50	20.75	17.75
February	34.26	32.00	23.50	32.00	34.75	57.00	30.00	250.00	11.00	15.25	20.00	17.25
March	37.21	35.70	27.50	35.80	37.55	63.80	32.54	275.00	11.30	16.70	22.00	17.75
April	38.50	38.50	34.00	38.25	40.00	73.00	38.00	350.00	9.75	19.50	24.75	20.00

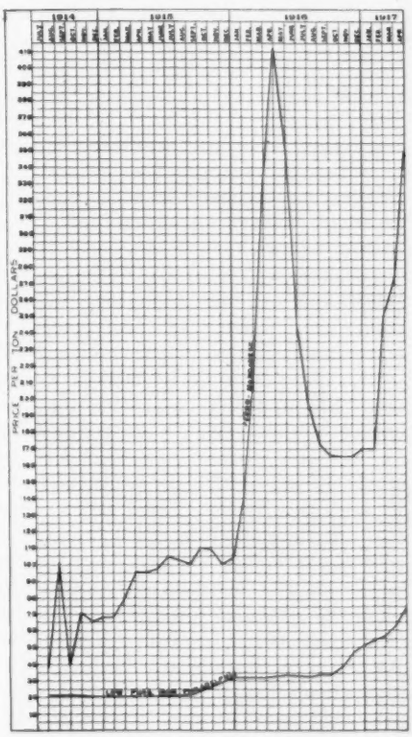


FLUCTUATIONS IN THE PRICES OF FOUNDRY IRON AND CAST SCRAP SINCE THE BEGINNING OF THE WAR IN 1914

$400 per ton. Still higher prices are predicted and some of the bulls who handle this material predict a price of $1,000 per ton before the end of the year.

To add to his other difficulties, the foundryman during the past year has faced an inadequate supply of fuel and the situation became so acute during the winter months that production of castings materially declined. Many factors contribute to the shortage and high price of foundry fuel, namely the tremendous consumption of this material by the blast furnaces, scarcity of labor and the shortage of the coal supply. Connellsville foundry coke, which sold at less than $2 per ton at the ovens at the close of 1914, has advanced to $10 and $11 per ton for spot shipment, and notwithstanding the slightly improved car situation, it is extremely doubtful whether prices will decline materially this year. Numerous expedients have been tried to compensate for the shortage of this fuel by the use of bituminous coal charged into the cupola with the coke and also by the employment of a crude oil residue, which is almost pure carbon and which materially increases the temperature of the iron. The large increase in the output of by-product coke has not contributed toward relieving the general coke situation, since the increment in the production of these plants has been absorbed by the increased blast furnace capacity completed only recently.

Plumbago or graphite is the principal material used in the manufacture of crucibles, and almost all of this material is imported from the island of Ceylon. Immediately upon the declaration of war, England placed an embargo on all shipments of this product, which was not lifted until the following March. During this period practically all of the reserve stock in this country was consumed and when the embargo was lifted, the demand for plumbago was so great that prices were advanced sharply and they have continued moving upward ever since. The stock in Ceylon was quickly exhausted, the supply having been small on account of race riots, labor troubles and a particularly heavy rainy season. Added to this difficulty was the shortage of vessels and until a comparatively recent date, it was almost impossible to secure bottoms.



THE ACROBATICS STAGED BY FERRO-MANGANESE AND THE MARKED UPWARD TREND OF LOW PHOSPHORUS IRON IN WAR TIMES

Prior to August, 1914, crucibles were selling from 3½ to 5 cents per number and plumbago could be purchased from 2½ to 7 cents per pound. Today No. 1 lump Ceylon plumbago is selling at 28 to 30 cents per pound, New York; No. 1 chip, 19 to 22 cents per pound and No. 1 dust, 10½ to 13 cents per pound. Instances have occurred during the past year where even higher prices were asked on account of excess charges in the way of freights, insurance, etc. The scarcity of plumbago was particularly acute in the summer and fall of 1916, due not so much to the scarcity of the material itself, as to the absence of freight space, very few vessels having been in service from the far east at that time. More boats were put on

late in the fall, however, and the plumbago tonnage increased rapidly during December, January and February. Recently some trouble has been experienced in obtaining shipments from Ceylon, due to the scarcity of gold and silver, which made it difficult for the banks to negotiate what are known as *rupee* drafts. At one time in February, business in all lines in the far east was almost at a standstill on account of this situation, but this recently was relieved by the British government, which sent large amounts of specie to Ceylon. The situation also was relieved by the negotiation of loans in India, which resulted in placing in circulation the gold and silver currency of that country.

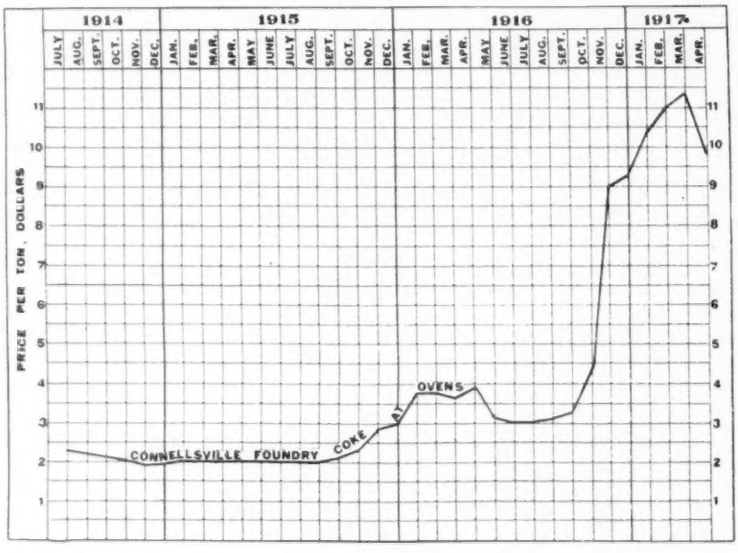
Production in Ceylon today is on a fairly satisfactory basis, averaging normal or slightly better. Marine freights, however, are unusually high. During normal conditions, shipments are made from Colombo, Ceylon, to New York, at 30 shillings per ton, whereas today it varies from 325 to 350 shillings. Present indications point to a continuation of shipments in fair quantity, but as long as the war continues, there is little likelihood of a sharp decline in prices. Even after the war, it is believed that this decline will be gradual, due to the fact that freight rates will be maintained at an exceedingly high level until the large number of vessels that have been sunk by submarines can be replaced. Some graphite has been shipped from the island of Madagascar, but the greater part was embargoed at Marseilles by the French government for a period of almost two years, and only recently it was released.

All manufacturers of crucibles were users of German clay prior to the war, but no satisfactory substitute has been found for it, although experiments have been made with hundreds of different varieties. The demand for clays at all suitable for making brass founders' pots is so great that prices have been advanced sharply, in one instance from less than $10 to $100 per ton. Railroad embargoes, shortage of cars and unsatisfactory weather conditions also have added to the difficulties of securing clays in this country. However, conditions today are considerably improved and stocks of both plumbago and clay in the hands of crucible manufacturers are much larger than at any time since war was declared. Increased cost of labor also has been a factor in adding to the cost of crucible production and notwithstanding the price of 18 cents per number prevailing for brass melting pots, the profit to the maker is not equal to that which he obtained prior to the war.

Among the numerous supplies used by foundrymen in the production of castings, refractory facings, such as are made from bituminous coal, probably have advanced more sharply since the war than any others. This is due to the fact that coal prices have increased markedly and to add to the difficulties, the shipments in practically no instance have exceeded 50 per cent of the manufacturers' requirements. During the winter months the coal scarcity was so acute that many of the producers of sea coal were compelled to buy their raw material at prices varying from $5 to $8 per ton, nothwithstanding the fact that the selling price did not exceed $6 per ton. From a basis of $3 per ton, prevailing in the summer of 1914, sea coal has advanced to $8 and this price barely covers the cost of manufacture. In some instances coal companies that have been furnishing raw material to these plants for many years, notified the producers this spring that they would not renew their contracts even at 100 per cent advance and as a result some of the sea coal makers are compelled to cover their raw material requirements from day to day in the open market. The coal shortage promises to develop a serious situation for foundrymen and in view of the large tonnage sold for export, the available supply for domestic consumption will be much less this year than heretofore. Concurrent with this reduced supply will be further advances in prices which directly will affect the manufacturers of sea coal. The cost of labor in these plants likewise has advanced fully 50 per cent and all supplies are costing from 100 to 200 per cent more than two years ago. Shipments of sea coal are deferred from 60 to 90 days, due almost entirely to the inability of the manufacturers to obtain an adequate supply of raw material.

Plumbago facings, due to the shortage and high prices prevailing for graphite, are being sold today on a higher basis than has prevailed heretofore in the foundry industry. No. 1 Ceylon dust is quoted at from 8 to 10 cents per pound, No. 2 dust from 6 to 8 cents per pound, and flying dust from 7½ cents per pound, delivered New York. While each manufacturer of plumbago facings has many different grades, nevertheless it can be assumed that those that are being sold at low prices naturally will contain a comparatively small percentage of Ceylon plumbago. Both Canadian and Korean graphites are being used extensively in the manufacture of facings, but in view of the scarcity and high prices prevailing for Ceylon plumbago, these likewise have sharply increased in value and quotations are practically double those prevailing two years ago. The normal freight rate on Korean graphite is $8 per ton to New York, whereas recently as high as $25 per ton has been paid. Coke blackings have advanced in line with the sharp increase in coke prices, manufacturers being compelled to pay from $9 to $11 per ton for their raw material. It is exceedingly doubtful if prices will decline in the near future, owing to the fact that the consumption of coke will continue heavy, owing to the tremendous requirements of the pig iron and casting manufacturers.

Molding sand can scarcely be considered to be a *war bride*, yet the cost of mining and shipping has increased fully 50 per cent during the past two years. Coarse sand which sold from


1914
1915
1916
1917
JULY AUG. SEPT. OCT. NOV. DEC.
JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
JAN. FEB. MAR. APR.
PRICE PER TON, DOLLARS
1 2 3 4 5 6 7 8 9 10 11
CONNELLSVILLE FOUNDRY COKE
OVENS

HOW CONNELLSVILLE COKE HAS PERFORMED SINCE JULY, 1914

75 cents to $1 per ton prior to the summer of 1914, is selling today from $1 to $1.25 and various grades of fine sand are quoted at $1 to $1.50 per ton. Labor costs before the war at sand pits in the central states varied from 17½ to 25 cents per hour and teams from 40 to 50 cents per hour. Today labor costs range from 30 to 40 cents per hour, depending upon the locality, and teams cannot be had for less than from 70 cents to $1 per hour. In addition, the cost of supplies, steel castings, repairs, etc., has advanced from 50 to 300 per cent and the cost of explosives has practically doubled. One miner and shipper of molding sand states that the increase in the cost of labor in the eastern section of the country during the past two years has been 57½ per cent. To add to their difficulties, the government will not permit the operation of vessels carrying sand in the Delaware bay at night, which materially increases the cost of shipping.

Among the smaller supplies used in casting plants, the percentage of advance on chaplets probably is greatest. This is due entirely to the tremendous increase in the cost of steel and tin and with plates selling at 6 to 7 cents per pound, further advances are anticipated. Early in 1915, the discount to consumers on all diameters of forged head chaplets was 70 and 10 per cent, as compared with only 33 1/3 per cent today. Two years ago the discount on double-head chaplets with round or square plates fitted, water back, round and square head chaplets and double-head chaplets with forged heads, was 75 and 10 per cent, as compared with only 40 per cent today. The increase in the extras also is large, from 4½ cents per pound for extra size plates to 12½ cents. Other supplies, such as bellows, shovels, swabs, riddles, etc., have been directly affected by the scarcity of materials entering into their manufacture, and prices have been practically doubled. Inability to secure leather, combined with the high price of this material, has compelled manufacturers to mark up quotations on bellows. Makers of riddles experience difficulty, even at the high prices prevailing, in securing wire and rims, while the shortage of swabs continues acute.

History of Nickel Plating for Stove Decorating

The ores containing nickel are of a complex nature and it is difficult to separate the nickel from other ores of cobalt, arsenic, copper, etc. Nickel alloys, such as German silver, were made long before the pure metal could be separated in a commercial way. In 1868, Monnier, of Philadelphia, patented a process for separating nickel, but for several years after that it was not obtainable in sufficient quantities to make possible its introduction in the mechanical arts. Wharton made nickel cooking utensils as early as 1873.

Nickel was not used in Europe before 1875, when extensive deposits of ore were found in New Caledonia and were shipped to France to be smelted. Nickel plating, or the deposition of nickel on iron and the softer metals, was invented by Isaac Adams Jr., of Boston, the patents having been secured from 1869 to 1872. During the winter of 1871-2 a working exhibit of the Adams process was shown at the Mechanics Institute's fair in New York City. At the same fair Fuller, Warren & Co., Troy, N. Y., exhibited Keep's baseburning stove with a fire in it. This was the first stove having a double row of mica lights. This stove was purchased by a New York banker who requested that all of the surfaces be nickel plated and polished to serve as an attraction in his bank. The cost of this work by the Adams process was considerably in excess of $100. We were informed that this was the first application of nickel to stove parts. I left the employ of Fuller, Warren & Co. in 1875, but prior to that time they had received a license to operate this process and had installed a nickel-plating department. In 1876, the Michigan Stove Co., Detroit, installed a nickel-plating plant and both Fuller, Warren & Co. and the Michigan Stove Co. exhibited portable nickel-plated parts at the Centennial exhibition in Philadelphia, in 1876. Prior to 1877 a plating firm in Alabama was making nickel trimmings for quite a number of firms. I was the first one to use a portable, carved nickel band on the front edge of the top of a cooking range. This was in 1877 or 1878. Portable nickel rings were used on the tops of baseburners before that time.

About 1885, the Michigan Stove Co. determined to nickel the edges of range tops and since the carved, portable edges did not meet with the views of the heads of this company, they decided to adopt a plain edge. Shortly thereafter, Ireland & Matthews made steel edges for us which were nickel-plated, but up to that time Matthews & Willard, of Waterbury, Conn., furnished the greater part of nickel trimmings for stoves. The entire upper portion of the Garland baseburner was made out of brass which was nickel plated. The use of elaborate nickel decoration followed the expiration of the Adams patents in 1887. In the west, carved ornamentation and a white unpolished background were the prevailing styles, while in the New England states, plain, polished nickel was preferred. Within the past 10 years plain nickel has come into general use.—*Abstract from manuscript entitled "History of Stoves", by W. J. Keep.*

Leaky Malleable Fittings

By Dr. Richard Moldenke

Question:—We are at present buying malleable fittings 3/16-inch thick and do not get one out of 20 that will stand 110 pounds air pressure without leaking. Cannot air tight castings be made more regularly?

Answer:—The malleable casting is originally a white iron product which is subsequently changed to the material we know by the annealing process. It therefore is subject to the enormous shrinkages in volume incident to that form of cast iron. The result is that the interior of a malleable casting is inclined to be more or less spongy or porous. If the metal is of poor quality, that is, oxidized, dirty, or not of proper composition, this difficulty from unsound interiors is accentuated considerably.

It is quite possible that in the annealing process, with the removal of the carbon from the surface, avenues of escape for air under pressure are opened up right through the casting. If the castings were packed in fire clay instead of iron oxide of some form, this removal of carbon from the outer layers of the metal would be greatly retarded, if not be overcome altogether. This would not hurt the malleable qualities of the metal sufficiently to unfit it for pipe fittings, but it would be a little weaker under shock and strain. The castings would doubtless be sounder under test and should be amply able to stand 110 pounds air pressure.

In actual operations on a large scale, sand would be easier to handle for a packing material than fire clay. Lime should never be used as it affects the surfaces injuriously under long-continued heat. Particular attention should be given the patterns so as to have good, big sprues and gates in order that the castings may have every chance to be as sound as white iron can be made. This, with annealing in sand or fire clay, will give castings exhibiting the carbon change (combined carbon to temper carbon) necessary to make a blackheart casting, but without the surface carbon being removed, thus making for the best grade of work.

Sensible Flask Equipment for Machine Molding

In Many Cases it is Advisable for the Sake of Economy to Alter the Design of the Pattern to Suit the Flask

By Paul R Ramp

INSTANCES frequently arise in foundries operating molding machines where it is more economical to alter the pattern than to make a new set of flasks. As a matter of fact, one of the most expensive items involved in the operation of molding machines is the

FIG. 1—PISTON VALVE BUSHINGS FOR LOCOMOTIVE CYLINDERS

cost of the flask equipment. It is the customary procedure to make the pattern first and to design the flask to suit the requirements of the pattern. However, there are many instances where it is advisable to reverse the operation and to adapt the pattern to the flask. While it is true that this practice has its limitations, nevertheless occasions frequently arise when this mode of procedure is advisable and frequently the quality of the casting can be improved and the cost of molding reduced.

Since it is possible to reduce the general dimensions of the pattern at the core prints only, the greatest economies only are effected in the depth of the flask and, therefore, this suggested mode of procedure involves

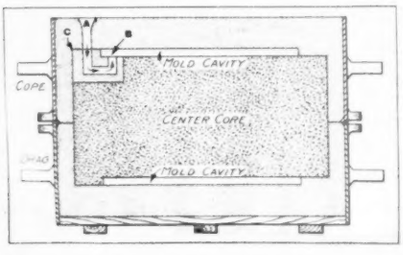


FIG. 2—CROSS-SECTION OF PISTON VALVE BUSHING MOLD

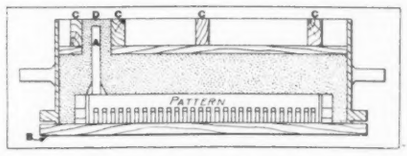


FIG. 3—CROSS-SECTION OF DRAG FOR ROCKING GRATE MOLD

the use of shallow flasks for deep molds. An interesting example of this is illustrated by the castings shown in Fig. 1, which are piston valve bushings for locomotive cylinders. When this work was received in the shop, these castings were considered too large to be molded in a flask that could be handled by two men, since this would provide only a small amount of sand over the pattern. As a result, the molds for these castings, for several years, were made on a large molding machine at a saving of approximately 20 per cent over hand molding methods. The large flasks used provided ample sand room

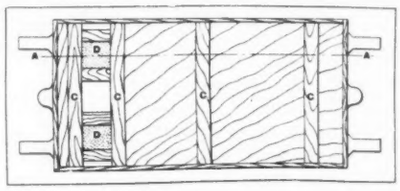


FIG. 4 — REVERSE SIDE OF DRAG, SHOWING CONSTRUCTION OF BOTTOM-BOARD

and the mold was gated at the joint. However, these large flasks had to be lifted with a crane, which materially increased the molding time. To effect further economies it was decided to mold this pattern in standard flasks of a smaller size, which could be handled by two men. To do this, however, the gating had to be changed, as indicated in Fig. 2, which is a cross-section of this mold made in smaller flasks.

A gate core was rammed into the main core when it was made. This gate is shown at *A*, Fig. 2, and enters the mold at *B*. The method of gating was an important factor in making it possible to use the smaller flask for this job and better castings were produced as a result of this change. Also, a saving of 80 per cent in the cost of molding was effected and the castings were cleaner, freer from slag, dirt and blow-holes than when they were made in the larger flasks.

Another instance illustrating the use of shallow flasks in preference to deep ones, is shown in Figs. 3, 4 and 5. Rocking grate castings, Fig. 5, have a lever attachment to effect the dumping of the fire and these are of such a length that they necessitate the use of a deep drag flask requiring an excessive amount of sand, making the flask too heavy for two men to carry. In this case a bottom-board was constructed, as shown in Figs. 3 and 4. When making the mold, the mold board, *B*, is placed on the table of the machine with the patterns in position, the flask is placed on the board and only a sufficient amount of sand is filled into the flask to cover the main parts of the pattern. The bottom-board, as shown in the cross-section of the mold, Fig. 3, then is lowered into the flask. If this mold is made on a squeezer machine, the ramming head is pulled over, the mold is squeezed, the head is thrown back and the pockets are rammed by hand. If the mold is made on a jar-ramming machine, the bottom-board is set down into the flask after the mold has been jar-rammed, and then the pockets are rammed by the further operation of the machine. While this method involves another operation, namely, the hand-ramming of the pockets, never-

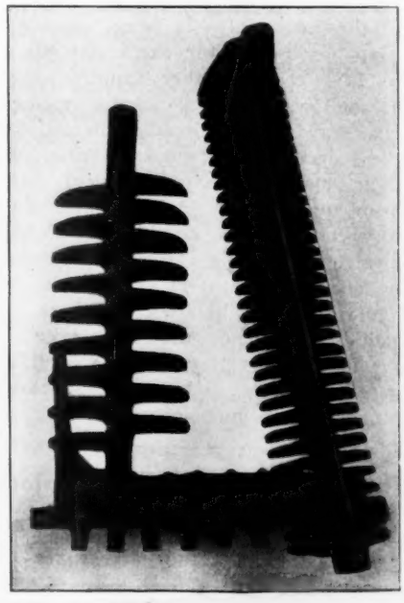


FIG. 5—ROCKING GRATE CASTINGS FOR LOCOMOTIVES

theless, the reduction in the amount of sand shoveled and in the weight of the molds more than compensates for this extra work. Fig. 3, which is a cross-section of this mold, shows the drag rammed ready to be rolled over. The shaking lever is shown at *A*. The pocket in the board that takes care of the lever in the mold is indicated at *D* and the height of the cleats on the bottom board, shown at *C*, is regulated by the depth of the flask and the quantity of sand desired in it. Fig. 4 is a view of the flask ready to roll over, showing the reverse side of the bottom-board and the pockets at *D*. This is an effective method of making castings of this design, since their quality is improved and the narrow pockets prevent swells on the lever. Wheels with long hubs and castings with long arms can be made at an extremely low cost by this method.

Packing rings are rather deep castings yet they can be made in shallow flasks at a decided reduction in the molding cost and this method also permits the use of standard flask equipment. Six of these castings are shown in Fig. 6, which must be free from defects, necessitating great care in ramming. To produce the drag half of these molds a mold board was constructed which permitted the pattern to drop down into it, as shown in Fig. 8. When the flask is placed on this board and filled with sand, the inside of the pattern is rammed to its full depth and only one-half of the outside. This, therefore, reduces the required depth of the drag and makes it possible for two men to handle the flask, thereby eliminating the use of a crane. A split pattern also could be employed to accomplish the same thing,

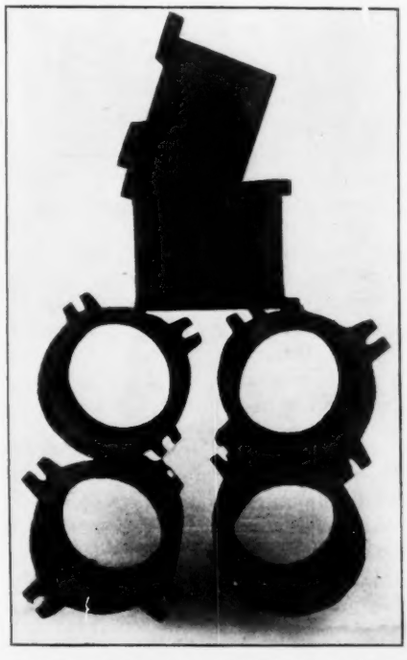


FIG. 6—PACKING RING CASTINGS

FIG. 7—PACKING RING MOLDS, SHOWING METHOD OF GATING

but unless the pattern were split lengthwise and a dry sand core were made, the amount of securing necessary to hold the cope in position would offset the saving effected by the use of a shallow flask. To make the cope for this mold a stripping board was devised, as shown in Figs. 9 and 10. Fig. 9 is a cross-section of this board, the cope pattern being indicated by *A*, the stripping board by *B*, and *C* is the pattern plate attached to the molding machine frame.

The four lugs, *E*, Figs. 9 and 10, were formed with cores placed in the flask against the pattern before the cope was filled and rammed. This eliminated the labor required to secure the cores and disposed of the fins between the green sand and the cores. The mold

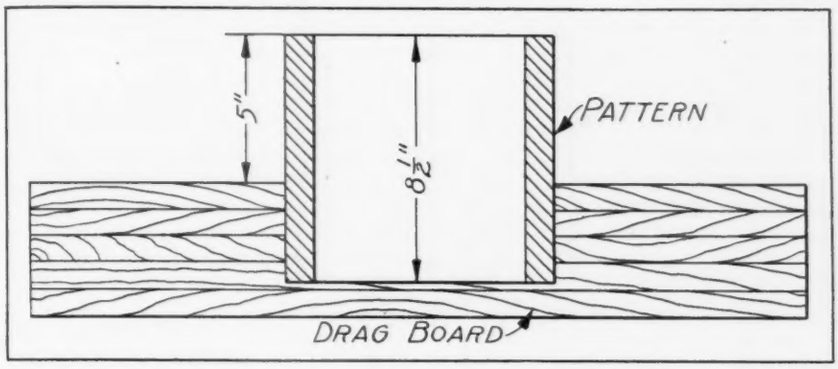


FIG. 8—MOLD BOARD FOR PACKING RING WITH PATTERN LOWERED INTO IT

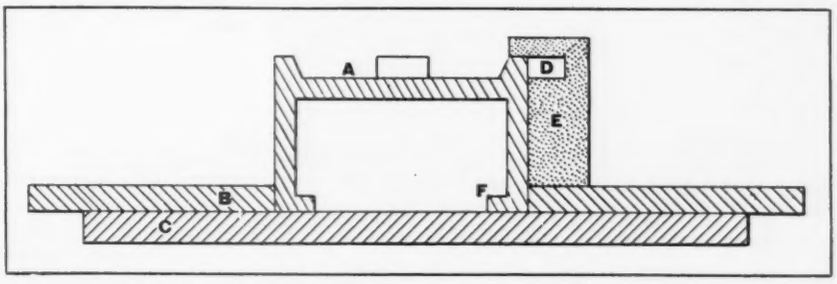


FIG. 9—CROSS-SECTION OF THE COPE PATTERN

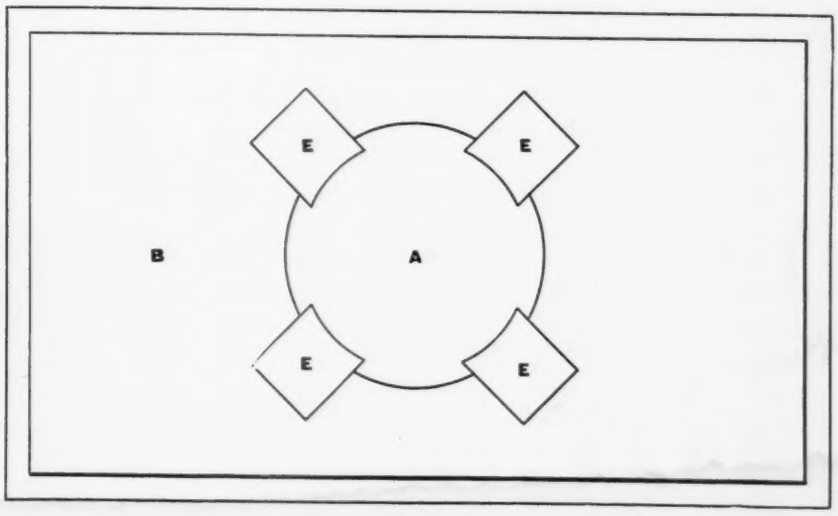


FIG. 10—COPE PATTERN AND STRIPPING PLATE WITH CORES FOR LUGS IN POSITION

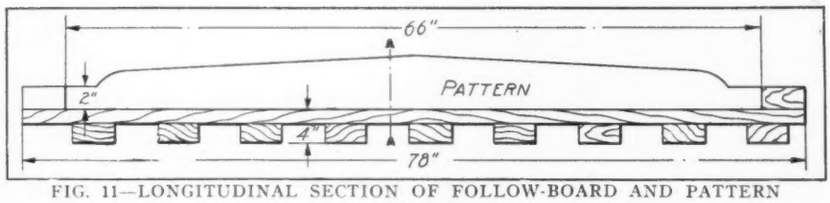


FIG. 11—LONGITUDINAL SECTION OF FOLLOW-BOARD AND PATTERN FOR GRATE BAR

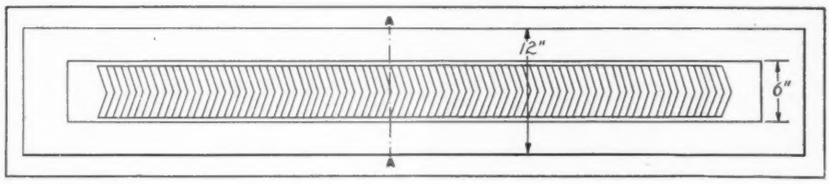


FIG. 12—PLAN VIEW OF GRATE BAR PATTERN

is gated in the center on top of the green sand core, as shown in Fig. 7. This method permitted us to use a standard set of flasks only 8 inches deep, but if the rings had been molded in the regular manner, a flask not less than 14 inches deep would have had to have been used.

Ordinary grate bars, as shown in Fig. 18, also can be molded in shallow flasks. Two ribs on these bars are wide and require a deep drag flask to take care of them. To make it possible to produce these castings on a molding machine, the follow-boards were so arranged that it was possible to mold a part of the bar in the cope. Fig. 11 is a longitudinal section of the follow-board with a pattern in place ready for receiving the flask. A plan view of the grate bar pattern is shown in Fig. 12. Fig. 13 is a cross-section of the follow-board and pattern and Fig. 14 is the same cross-section with the flask in position ready to receive the sand. A cross-section of the drag mold is illustrated in Fig. 15. At *A* is shown one of the small green sand cores, which extends above the joint, affording the machine operator an opportunity to repair the mold or to blow out any dirt that may fall into the small spaces between these green sand cores. By this method it was possible to successfully make these molds by machine. The cope was made on a stripping plate, while the drag was made on a jar-ramming machine. A longitudinal section of the cope mold is shown in Fig. 16 and the drag in Fig. 17. By molding the entire pattern in the drag, there was less strain on the deep flanges, less sand was required and the mold was handled more easily than by the previous method pursued. While the depth of the cope was greater than if the entire pattern were in the drag, nevertheless the total depth of drag and cope was much less than that of flasks which are considered standard equipment for this kind of work.

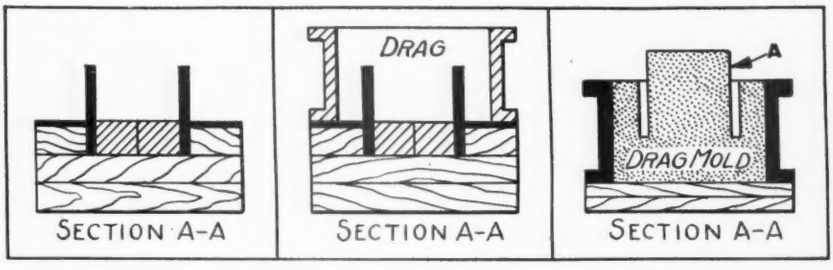


FIG. 13—CROSS-SECTION OF FOLLOW-BOARD AND PATTERN

FIG. 14—CROSS-SECTION OF FLASK ON FOLLOW-BOARD

FIG. 15—CROSS-SECTION OF THE DRAG MOLD

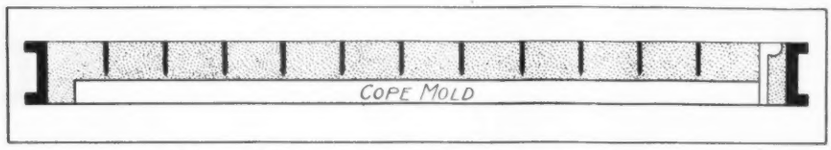


FIG. 16—LONGITUDINAL SECTION OF COPE MOLD

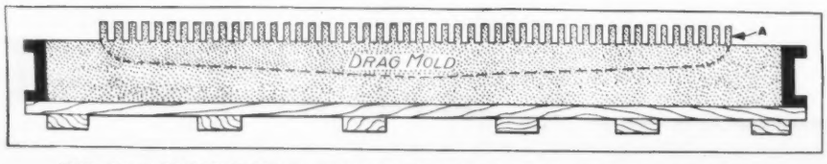


FIG. 17—LONGITUDINAL SECTION OF DRAG FOR GRATE BAR MOLD

Loss in Melting

By W. J. Keep

Question:—We use agricultural scrap almost entirely and we would like to know what the melting loss should be. We estimate it at about 10 per cent.

Answer:—You are doing very well if your loss does not exceed 10 per cent day after day. It is almost impossible, however, to ascertain exactly the losses in melting scrap, since there are so many chances for error with a mixture of pig and scrap. The loss generally is about 5 per cent, but the sand on the pig is a considerable part of this. However, if the scrap is clean, you may not have a greater loss than 5 per cent.

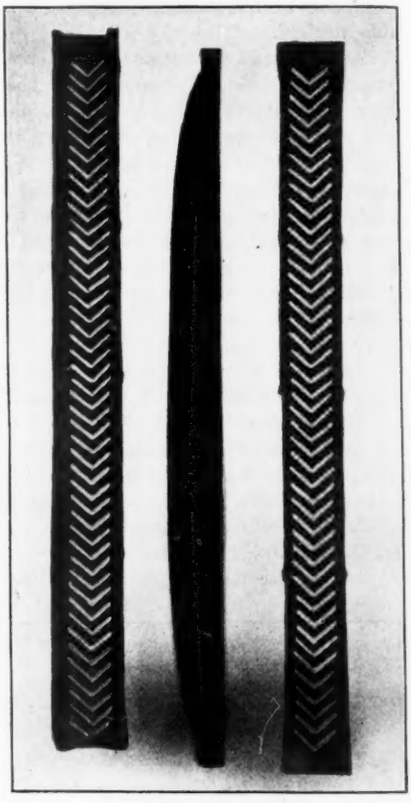


FIG. 18—GRATE BAR CASTINGS

The Pangborn Corporation, Hagerstown, Md., manufacturer of sand-blast equipment, has taken over the business conducted by Elmer E. Perkins and George A. Cooley, Monadnock building, Chicago. Mr. Cooley will join the forces of the Pangborn Corporation, while Mr. Perkins will continue to handle condensing dryers and dry kilns.

Electric-Arc Welding for Foundry Purposes

A Few Practical Applications of this Economical and Convenient Method of Construction and Repair in the Foundry

By R R Clarke

THE progressive foundryman is always on the lookout to find in development along other lines, some detail of progress or novelty of experience that might profitably apply to some phase of his own endeavor. He is quite conscious of his dependence on men of other callings for many of his own needs and realizes that any announcement of progress, along any line however angular to his own, is liable to involve a suggestion, a probability of decided benefit to him if properly applied.

Opportunities for Electricity

A discovered or developed advantage along any line is, in application, perfectly legal property to any other, and the possible benefits thus admitted to the foundryman are such as to justify a watchful policy in general. The man of most any calling will do well to watch electricity. In that field are located many surprising features of modern progress and possibility. It is practically in its youth. What has already been accomplished in its application to industrial service is merely suggestive of what remains for accomplishment. Nor is the foundry by any means out of contact with its stronger currents of possibility. The problems to which it may prove a medium of solution, the difficulties it may dissolve and the practice to which it may attract change and increased efficiency as it becomes better understood and applied are found in foundries everywhere. Consider the facilities in equipment to which as a heat-producing agent it holds great promise. We have always dried cores in large ovens by means of coal and coke, air and oil or gas combustion, suffering more or less inconvenience in controlling temperature and considerable undue expense in maintaining fuel costs as well as labor incidentals necessary to continued use of certain fuels. Could we dry those cores in a battery of small ovens or larger ones for that matter, built to suit our individual requirements and operating either independent in conjunction with each other, by simply making a contact or increasing or reducing an independent current to the degree of realizing a specific heat in immediate demand? Could we thereby, without shifting from lower to upper shelves, start our cores drying slowly under low and proper temperature and run them slowly through all degrees of temperature essential to most pronounced efficiency in baking cores? And after those cores are baked, could we, to avoid burning them and to permit them to cool slowly with the gradual recession of supplied heat, merely turn off or reduce a current instead of shifting them around or taking them out of the oven on burning hot plates? We heat irons in furnaces, build fires, burn gas jets and resort to quite a few other inconvenient methods of drying molds. What could we do with a resistance coil?

We jar the tables of our machines, swing the cumbersome parts of machines into different positions, press sand in flasks, and draw patterns by hand, compressed air or reciprocating parts of shaft-driven machinery. What might the magnet have to offer along these lines? When a piece of flying steel or iron embeds itself in a man's eye, we march him up to the magnet. What might be possible to the magnet in drawing our core-rods and wires from our heavy brass and bronze castings—without bending and twisting those wires and rods into all kinds of shapes? In part these ideas may appear in advance of applying facilities, hampered by limitations not yet outbounded. Largely they are merely suggestive and representative of promising possibilities, in no wise ephemeral. Time was when we tediously picked iron from brass turnings, filed and chipped at returned scrap castings to determine presence or absence of iron screws, bolts, plugs and the like, hauled our different metals and castings around on wheelbarrows and man-drawn wagons, etc. Electricity has changed all this. With tremendous advantage we now inherit as an actuality the magnetic separator, the magnetic iron detector and the electric motor truck. Are we to consider such things as these the all of it or look on them as mere criterions of greater things yet possible? These are questions the great majority of foundrymen have yet to answer in a practical, applied way and they may do well to accord them serious analysis as the possibilities and applications of electricity become more and more understood.

One of the more revolutionary practices with which this modern servant has divested our industrial experience is electric arc-welding. It has not invaded this field of service alone, being contemporary therein with the thermit, the autogeneous and other processes. What its merits or demerits may be as compared to these other processes in general is an argument into which this discussion is not attracted. Each process being admittedly preferable to certain classes of service by virtue of its peculiar adaptability to that service, it suffices to say that the electric is not without its own broad element wherein it will operate with maximum efficiency and facility.

Principles of Arc-Welding

The average foundry can use an electric welding outfit in many and diversified instances and along varying lines of service. A brief insight to the principles of the process may be found attractive to general interest and value. If, through a closed circuit medium of prime conductivity a current of electricity be unobstructedly passed, that current will occasion little or no heat at any point of its passing. On the other hand, if that medium be inherently low in conductivity, or so shaped or formed as to arrest the progress of the current, or disconnected at any point so as to admit a slight intervening space, the passing current will then have to contend with a resistance, from which as a consequence heat perceptibly develops. The principle finds practical application in the resistance coil as existing in different every-day commodities and the incandescent light bulb where the heat reaches incandescent intensity.

If two conducting mediums be placed in close proximity with little open space between them and a strong current be sent through the one, the current will travel to the open space, encounter the resistance occasioned by the low conductivity of the atmosphere, tear through it and light on the opposite medium. In leaping the gulf the line of motion is not straight, but bowed or arc like and the energy and its resistance so great as to

develop an intense heat and a consequent brilliant light. From these phenomena we derive the term arc-light, arc-welding, etc., the light taking the form of the bow-like of motion and resembling an arc.

As indicated, great heat features the process affecting both ends of the broken circuit to the degree of fusibility, that is at the source of the arc in the one and its terminus in the other point of medium occurs a melting of fusible elements. Being in direct line of the currents' motion through the arc, fine particles of molten metal in the source are carried over and deposited in the molten pool on the other end. In transit these particles take the form of a spray and very likely represent the molecular if not the atomic state of the element.

How Welding is Accomplished

Technically, the supplying end of the circuit, that is the rod terminating in open space in direction of flowing current, is known as an electrode. Electrodes in arc-welding are of metal or carbon, the former applying to the lower, and the latter to the higher current. The carbon is also used for cutting, an example of which occurs in welding cast iron where a piece of cast iron held in the arc springing from a carbon electrode and terminating on the object of repair or construction, will fuse and blow into the molten pool existing at this terminus. This method can be resorted to when an electrode of a certain element is not readily available.

In fusing, passing through and depositing in the atmosphere, it is quite apparent that as in the case of naked molten metal, the fused material will be affected by oxidation. If the welding could be done in a vacuum—in the very premises and absurdity—better results could doubtless be had. As it is, the problem reduces to that of deoxidation; the same as in the molten metal case. Efforts are being made to take care of this feature in the preparation of metal electrodes. In the incandescent light bulb, the heat is generated in a vacuum and offers an excellent opportunity for the foundryman to convince himself of the evils of oxidation. With the current on and the light shining brightly, break the end of the bulb, admit the atmosphere and notice how quickly its oxygen reduces the fine carbon thread or metal wire, as the case may be, to a worthless oxide.

Briefly, the whole phenomenon of electric heat and all its practical applications rests in the fact that the interruption of the easy passage of a current through a conductor, produces heat in the conductor at the point of interruption. It follows when for a short space the conductor loses of its conductivity, when it suddenly diminishes in size, or when it admits a short section of substance or element lower in conductivity than its own. On this latter principle arc-welding is based. That the little resistance of the atmosphere could produce the magical effect of the heat developed may at first sight appear incredulous, but it must be reckoned with that this little resistance is invariably active, disputing the most infinitesimal unit of current progress and operating against tremendous volume and an energy all but infinite. At the arc in ordinary welding with the metal electrode the voltage ranges from 30 to 35 with the amperage approximating 100. The process admits practical application in fusing iron on iron, steel on steel, copper on copper, iron on steel, steel on iron and copper on iron and steel. With the alloys of common usage, complications generally arise and this particular feature will be considered later on.

Electric welding performs a task which ordinary forge welding cannot well accomplish. The presence of copper or copper-base metal has a detrimental effect on the welding properties of iron. By pitching a couple of copper pennies into a blacksmith's forge fire, his chances of getting a good weld on pieces of iron heated in that fire are practically eliminated. The same consideration applies to pieces of iron manipulated in or around copper-base alloys.

Every-Day Welding Problems

When the German-clay crucible through the instrumentality of the war became a thing of the past, and the American product came forward as a substitute, we realized the necessity of keeping our furnace tongs in the very best of fitting shape and condition. Purchasing different makes of crucibles wherever obtainable we experienced variation in shape and were obliged to frequently reset the tongs. Because of the repeated resetting of the single pair of tongs which was delegated to this service, bad fracture developed at a critical point. The foreman blacksmith admitted his inability to repair the tongs and suggested that we try the electric welding process. We did and got a very satisfactory result. Besides filling in and building up around the crevice, we reinforced those parts that had scaled and burned away, building up with the inburned copper-base alloy more or less frequently. The tongs have been in continuous service several months, giving no evidence of weakness at the welded points.

To determine the merit of the process thus applied and independent of any chance element that might have entered into this particular case, we took two strips of ordinary ⅛ x 1-inch wrought iron, immersed them in a pot of molten bronze, permitted the metal to burn on and into them and after cooling delivered them to the arc-welder. There we placed the two ends together and had them welded. As an efficiency test we placed the one end of the welded strip in a vise clamping a short distance from the welded joint and bending to right angles with hard and quick blows from a hammer. The welded joint participated in the bending but gave no evidence of breaking and left us quite satisfied that the often advanced claim of 80 per cent original strength is conservative. This assurance prompted a searching inquiry into those items of furnace equipment susceptible to the advantages of the process and led to a surprising revelation.

Repairing Tongs

Tongs of all kinds are repaired by this process. When a pair burns away and weakens it can be built-up and strengthened. Should any section break or crack, the crack can be welded shut, or the broken-off part recovered or a new section made and welded to the tongs. The same consideration applies to hooks, chains, bails, shanks, furnace-cleaning bars, stirring rods or skimmers, rings, links, etc. Often a broken link or ring in a pair of lifting tongs can be repaired without even taking the tongs apart. Two cleaning bars or skimmers shortened by use to uselessness can be laid end to end and the equivalent of a new one quickly and cheaply realized. When carrying-tongs or shanks crack in the circular band or the guards start to break away, no drilling, countersinking, patch-cutting and riveting are necessary; arc welding is better, neater, quicker and cheaper. Even in the making of the shank, time and expense can be saved. The guards are not inseparably necessary to the forging process. Shank and guards can be forged separately and later welded together. Building up parts as they become depleted at points of greatest wear offers a splendid opportunity. The wearing points of the ordinary carrying-bail may be built up as they approach the limit of safety in a cheap and efficient manner by the electric process. S hooks and all lifting or carrying appliances may be repaired in a similar way.

While going over our furnace equipment recently and in the interests of assured safety—something every foundry ought to do in a uniformly periodical way—we discovered the forged link attached to the end of the piston rod in the air hoist badly worn at the bottom. The wearing away had been confined to a very limited area and had formed a pocket. This pocket was built up and the lower part of the link reinforced all around, thus saving it from the scrap pile. In the future, new links of this kind will be made by the arc-welding process. An oval disc is cut from a plate of ⅜-inch boiler steel. A center hole and two side holes are punched or drilled and the side holes are countersunk on both sides of the disc. A short piece of good round merchant steel is bent in a *V* shape, the ends of the *V* are placed in the side holes of the disc, the upper ends being flush with upper side. The steel is then welding around the bottom and top countersinking, the top filling is filed flush, and the job is complete.

Another example of economy recently suggested itself. In holding tile lining to the iron furnace lid we resort to a square washer nut, a top nut and a stud threaded at both ends. One end of the stud is screwed and riveted into the washer nut, giving the effect of a flat-headed bolt. By punching a little larger hole in the washer nut, admitting the stud unthreaded and extending it to within ⅛-inch of being flush in the washer, the joint can be electric welded, thus eliminating threading one end of the stud and tapping the washer, and gaining the advantage of a solid-headed bolt.

Avoid Carelessness

In arc-welding, as in any repair work, the operator must use care to insure a safe job. Around furnaces and metal manipulating equipment no chances should be taken. The electric arc weld, in common with nearly all other methods of repair, admits the possibility of inefficiency and a hidden weakness. The last applied unit of forge heat may burn the iron, the last blow of the hammer may weaken a rivet, the last turn of a wrench may twist the bolt, the last spark from the electrode may impair the weld. Where strength and safety are of paramount issue and judgment wavers on unstable bases of decision, banish all considerations except strength and safety. Further, no such item of repair should enter routine service in advance of an exacting test on its qualifications, a principle well-applying to all conditions of equipment installation, new and old or repaired alike. Practically all other phases of foundry effort are equally susceptible to the advantage of the arc-weld. The flask frame, which is used to secure extra heights and depths in cope and drag to accommodate unusual patterns may be made by the welding process. Frames 1 and 2 inches in height are convenient in size. Common merchant flat iron stripping from 1/16 to 1/8-inch thick is cut into lengths slightly exceeding the perimeter of the flask.

Altering Flasks

A pattern is made and a cast frame whose perimeter (outside measurement) is slightly less than the outside perimeter of the flask but greater than the inside is roughly molded. The middle points on one end of iron frame and the iron stripping are marked. The stripping is heated, clamped onto the frame middle point to middle point, and bent around the frame, both ends almost meeting at the middle of opposite side. A thin sheet of asbestos is slipped between the cast iron frame and the ends of the stripping. While the ends are firmly held in place, a union is electrically welded. The welded frame can then be removed from the form. Small pieces, say 1¼ inches long, are cut from 1/16 x ½-inch stripping and welded to the frame at the most advantageous points, allowing for about a ⅜-inch projection. The projecting ends may be filed to a slight taper to facilitate placing the frame on top of the flask. After the welded union is roughly dressed, a commodious flask frame of maximum durability has been completed at a very low level of producing cost. The form for bending the iron into frame shape can also be realized by screwing some half-dozen studs into a smooth-surfaced iron plate, one stud at each corner of the square and one at the middle point of each side. A flask itself can be made the base of the form by attaching iron strips at these points, inside position in the flask being understood. Electric welding may also be used to make sheet iron snap-mold bands, whether of the slip-pocket variety or of the cope and drag type, separately set in the snap frame when ramming up the mold. These bands are used in heavy work, where the metal pressure overtaxes the mold sand resistance when unsupported. They can be very neatly and cheaply made by bending the sheet iron to proper shape and dimension and welding a union.

At this juncture the question of welding the broken flask, instead of patching it, naturally arises. If the flask be of steel, the opportunity is an excellent one and applies to any detail of construction or repair such as attaching parts, joining adjacent sections, repairing fractures and burn-outs, strengthening weak places, etc. If it is desired that a flask be two or three times as deep as manufactured, two or three such parts may be clamped together and electrically welded, either in sections of union or in total. If desirable to permanently heighten a cope or deepen a drag by an inch or two, the frame may be welded at little expense.

Much has been written about the advantage of the arc-weld in saving defective castings by welding shut or filling in the cavities of defect as well as building up the shrunken surface. In the case of the steel casting, the electric process is distinctly applicable and practical. Large spokes in cast steel wheels in fracturing are electric welded to satisfactory purpose and with no sensible impairment to the wheel in subsequent service. A ruling very often observed, however, and one which illustrates a slight suspicion of the efficiency of the process is that no two adjacent spokes shall be so repaired. As affecting the non-ferrous consideration, it is thought that pure copper adapts itself to electric welding, but the casting made from a non-ferrous alloy of copper base has much to argue against the practice. Actual trials show that low degree melting elements in the casting burn out and that the electrode sometimes fails to furnish a properly filling-in supply. The appearance of the weld around the edges of the burn and even in its more interior surface is far from prompting enthusiasm. To properly tin a surface there must be proper temperature in both "tinning" surface and "tinning" instrument. To properly burn in a copper-base casting the same condition largely prevails and the heat of the arc cannot well be adjusted to the requirements in question.

Making Tumblers

Malleable castings may be satisfactorily repaired by the electric-arc process. Any parts of machines, shaft hangers, bearing and bearing caps in which the malleable is used offers an opportunity in so far as its susceptibilities to efficient union are concerned.

Electric welding proves satisfactory in both construction and repair work. The foundry tumbling barrel may be taken as an example. An efficient and handy method of constructing a tumbling barrel is to use cast iron heads and to roll a cylinder of heavy boiler steel into which the heads are

riveted. At the end of the roll or where the two edges meet, a heavy buck-strap is firmly riveted onto the adjoining sections. In hard and heavy service these rivets invariably loosen, become worn in the holes and have to be replaced. The union can be effected to within at least 75 per cent of undivided boiler steel strength by means of the electric weld and the strap may be discarded. It is also good practice to use a number of straps fastened by only a few rivets, and then to electric weld all around the outside of the straps and over the seam from the inside. Either method will produce a better, neater and more lasting job at a much reduced figure than that of the complete riveting process. Large foundry supply bins such as those used for keeping flour, talc, plumbago, parting, crushed charcoal, lime, fireclay, facing sands, etc., foundry and core-room boshes, and all such equipment can be readily constructed on the same principle. Often it is necessary to construct short furnace stacks out of fairly heavy material. It is expensive to build up a stack section by section through the medium of the rivet. This may be avoided by laying the sections together in a straight line and securing them with the electric weld. The dust guards for buffing to highly duplicated classes of chines, belt-shifting mechanism, etc., may be constructed or repaired by electric welding.

Often a circular core rod firmly joined together or a core rod longer than the longest of a similar assortment at hand is needed. The core-maker overlaps ends and binds them together with twisted wire. A touch of the electrode will give better and often cheaper results. Likewise, complex and difficult shapes of core rods mold sand anchors and jaggers applying to highly duplicate classes of work may be made.

Copper can be welded on iron by the electric process. Frequently a foundry is called upon to run copper-base metal on iron rods. To insure permanency in the position of the metal, grooves are cut in the rod in mistrust of the efficiency of the burn-on to meet the demands of the occasion. The rod is materially weakened by this groove-turning process. In doing this work by the arc-weld process, the rod is cleaned in the vicinity of copper-base metal. It is nicked all around with a cold-chisel, and patches of copper of consistent thickness are welded on this nickel surface. In casting, the copper-base metal should be poured at a conservatively high temperature. The copper patch adheres firmly to the iron, the pouring metal burns hard to the copper patch and the job is above suspicion so far as retention of position is concerned.

The process derives much of its efficiency from the knowledge and skill of the operator, experience being a great asset to successful manipulation. Anyone familiar with electrical principles and appliances in handling, can take the instrument, create an arc and make a deposit, but it remains for the experience-taught operator, with his artistic touch, sense of heat, and knowledge of current pressure and volume, to give the even, symmetrical surface appearance covering an efficient weld.

Care should be exercised in preparing the parts to be welded. All surfaces should be made scrupulously clean, exposing untarnished metal as far as can be realized. *V* shaped grooves of amply spacious dimensions should be cut along the line of all crevices or fractures, and holes should be explored to their bottoms for evidence of corroded or slowly oxidizing metal. All adjoining edges to be seamed together should be champered as far as practical to afford the arc greater depositing surface and volume. Only the best depositing material obtainable should be used.

Chill Cracks in Lathe Beds

By W. J. Keep

Question:—We cast our large lathe beds with cast iron chills about 4 to 5 inches long, laid end to end the entire length of the bed. Where the chills join, cracks about ½-inch deep extend in from the edge about 1 inch and down about ½-inch. We are using the same method of molding as previously and we have not changed our iron mixture. The analysis of the iron in the casting is practically the same. We have tried leaving the casting in the sand over night until it is thoroughly cooled and other methods common to foundry practice. Do you think using a thinner chill would help? These cracks are hardly noticeable and appear after taking off the first cut.

Answer:—You say that the analysis of the iron in your castings is practically the same as when you had no trouble. Probably a closer examination of such analysis will disclose the trouble. Ask the advice of the chemist who makes the determination. Less silicon or greater sulphur would produce the result. In these times pig iron or coke or limestone cannot be depended upon. Probably the trouble is not in the pig iron or scrap. If the coke has higher sulphur, it will go into the iron. Pyrites in limestone that cannot be seen except by wetting the stone, will impart nearly all of its sulphur to the iron. What you may consider practically the same may vary in a manner which will produce the result. If all the conditions are the same, the result will be the same. The process of chilling is instantaneous and the crack occurs before the iron is set in unchilled portions. A chill produced by higher sulphur is a weak chill. As soon as the iron strikes the chill, it becomes solid and shrinks the whole length of the bed, but some roughness in the chill surfaces does not allow the whole to pull in from the ends. It would not anyway in your case, but the portion lying on each chill must be treated independently. You have each surface 4 inches long becoming solid and shrinkage instantly about 0.01-inch. The iron has very little strength and pulls apart at the junction of two chills. Such a crack may make the bed unsalable, but is not usually a line of weakness because it occurred before the iron set behind the chilled part and all strain was removed. Your chill surfaces should be smooth and lie close together so as not to leave a thin film of unchilled melted metal at the junction. In some way decrease the amount of shrinkage just enough to prevent the crack. First, be sure that sulphur is as low as 0.07 per cent or less. Keep the phosphorus low, say 0.05 per cent, so that the iron will set quickly, with the manganese about 0.05 per cent to lessen the total shrinkage. When all this has been done, increase the silicon until the cracks disappear. I would not make the chills thinner or treat the solid casting in any special way. A casting with a chilled long surface has a strain the entire length and should be handled carefully, with no jar in moving, and the longer it can stand before machining, the better. Seasoning allows the grains to adjust themselves and remove the pull in the chilled surface.

The Mott Sand Blast Mfg. Co., 893 East 134th street, New York City, has just completed a new plant at Brooklyn, N. Y. The new quarters have been especially fitted up with facilities for manufacturing sand blasting and allied equipment on which the company has specialized.

Joseph Harrison, formerly foundry superintendent of the Allis Chalmers Mfg. Co., Milwaukee, Wis., and for the last several years Milwaukee representative of the J. S. McCormick Co., Pittsburgh, foundry supply dealers, died recently at his home in Milwaukee.

Systematic Pattern Storage Aids the Foundry

Well Arranged Storage Facilities and a Simple but Comprehensive Record of Patterns are Principal Requisites

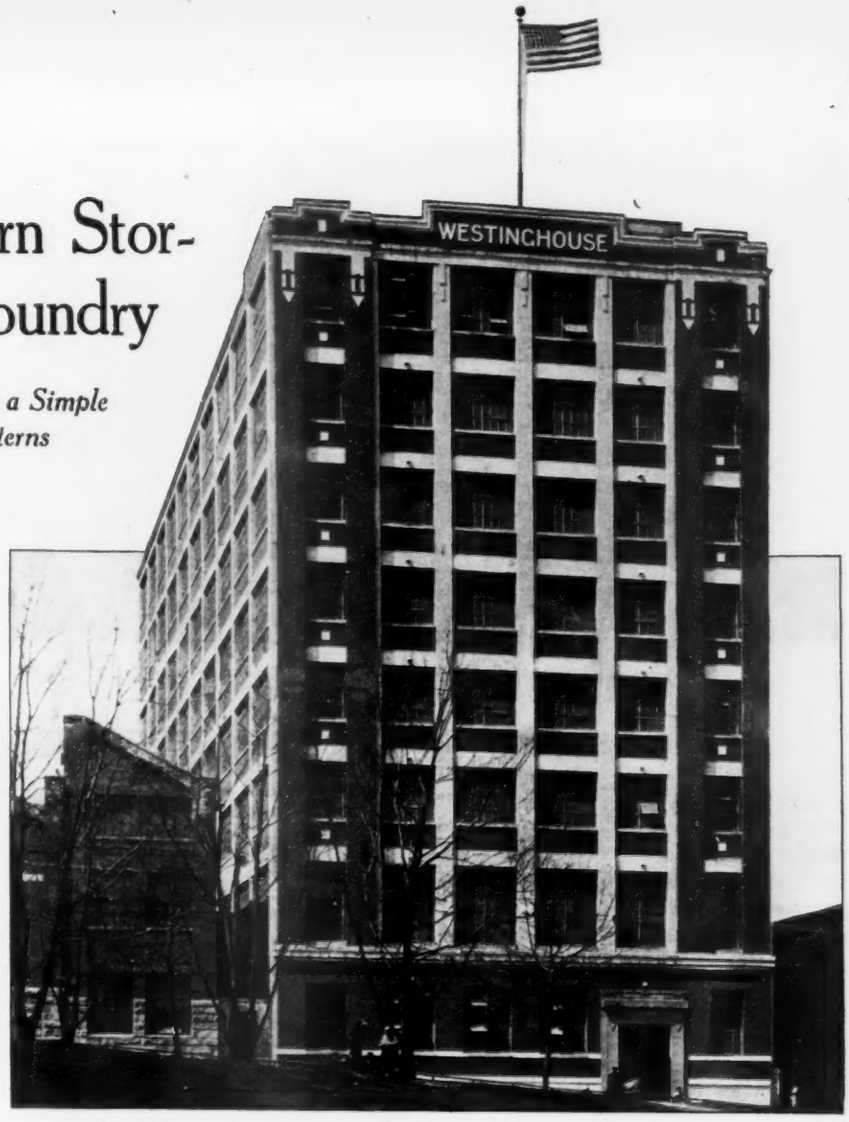


FIG. 2—A SPACIOUS BUILDING IS AN AID TO GOOD STORAGE

A TENSE air of expectancy dominated the dingy office of the International Castings Co. Chapman, the core room foreman; Ashland, the chief patternmaker; Elsey, the head draftsman; and O'Malley, boss of the molding floor, anxiously waited for the superintendent, Randall, to state the reason for his hurried summons.

After carefully extracting a few papers from the multi-colored assortment on his desk, Randall swept the faces of his audience with a critical eye and then plunged into the subject of the meeting.

"Something is radically wrong with our organization. We are losing altogether too much time hunting for patterns. Listen to this:"

Picking up a telegram from the Universal Engine Co., he read:

"Rush five hundred gray iron castings, our pattern three six two nine. Pattern sent January fifteen, nineteen sixteen, for previous order."

"Now although we made 100 of these castings only a few months ago, none of you gentlemen were able to locate the pattern. We looked high and low, and I venture to say that the time spent in trying to locate the missing pattern was worth at least $50 to this company. After waiting a day, I was obliged to wire the Universal people for a drawing so we could make another pattern. Listen to their reply."

"Cancel order, cannot wait for new pattern, letter following."

Randall picked up a letter from the desk and passed it to the foremen. They read:

International Castings Co.,
Pleasantville, O.
Gentlemen:

We regret that we were obliged to cancel our telegraphic order for 500 castings, our pattern No. 3629. The castings are required to complete a rush job for the government, and the delay which would have ensued if we had waited for you to make a new pattern would have made it impossible for us to fulfill our promise of early delivery.

Consequently we delivered a duplicate pattern to a local foundry which is in a position to fill our order immediately.

You will understand that our action is no reflection on the quality of the castings you have furnished us on past orders.

Very truly yours,
UNIVERSAL ENGINE CO.

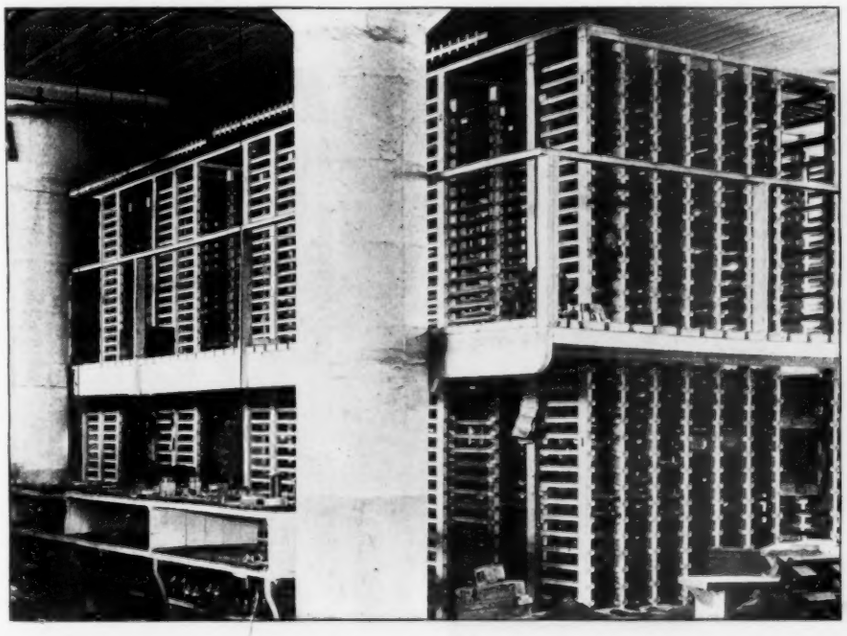


FIG. 1—MACHINE PATTERN PLATES ARE STORED ON NUMBERED SLIDES

"So you see, gentlemen," said Randall,

FIG. 3—EVERY PATTERN MADE IN THE PATTERN SHOP IS CARDED EVEN BEFORE WORK ON IT IS COMMENCED

"our lack of system in handling patterns lost us a mighty profitable job. All of our efforts to bring the quality of our catsings up to the present high standard go for naught in this case simply because our organization does not provide for keeping a reliable record of our patterns. What have you to say about this fall-down, Ashland? You're the man who is supposed to know where our patterns are kept."

"Well, I guess our system is a little weak", admitted the chief patternmaker. "You see we don't keep a record. We simply have a rack or bin for every pattern, and we chalk the number of the pattern on rack which holds it. If a pattern is missing, we take for granted it is in the foundry. We have had only a few cases where patterns have gone astray. The Universal Engine Co. pattern is the first one we have lost in a couple of months. I doubt if it would pay to keep a lot of records of our patterns."

FIG. 5—STENCILED NUMBERS ASSIST IN IDENTIFICATION

"Wait a minute," broke in Randall. "You say you think it wouldn't pay. Why man, the money we lost on that Universal Engine deal would pay for the maintenance of a complete file system for a year! We are going to start a record of patterns, and we are going to start it today."

"Ashland, have your clerk make out a card for every pattern we have. When you deliver a pattern to the foundry, you charge it off the card. Elsey, when you make the drawing for a new pattern, send a memorandum to Ashland so that he can make out a card for it. Then, Ashland, you are to write on each card the number of the core box or boxes required with each pattern, and then go over the matter with Chapman so that there will be some sort of a check on core boxes for the core room and pattern storage department. O'Malley, when you return patterns to the storage department, give Ashland a list of patterns so that he can check them off the cards. A week from today I shall expect you men to come here and tell me how the new system is working. That's all for today."

* * *

It is almost unnecessary to state that in the course of a few months Randall's plan developed into a smoothly running system of records which saved the company many times its cost in improved service to its customers. If the average foundryman would face the pattern storage problem with determination, and would employ the effective measures adopted by the International Castings Co., there would be less embarrassment in promptly producing castings. So many foundries have neglected to systematically handle patterns that the

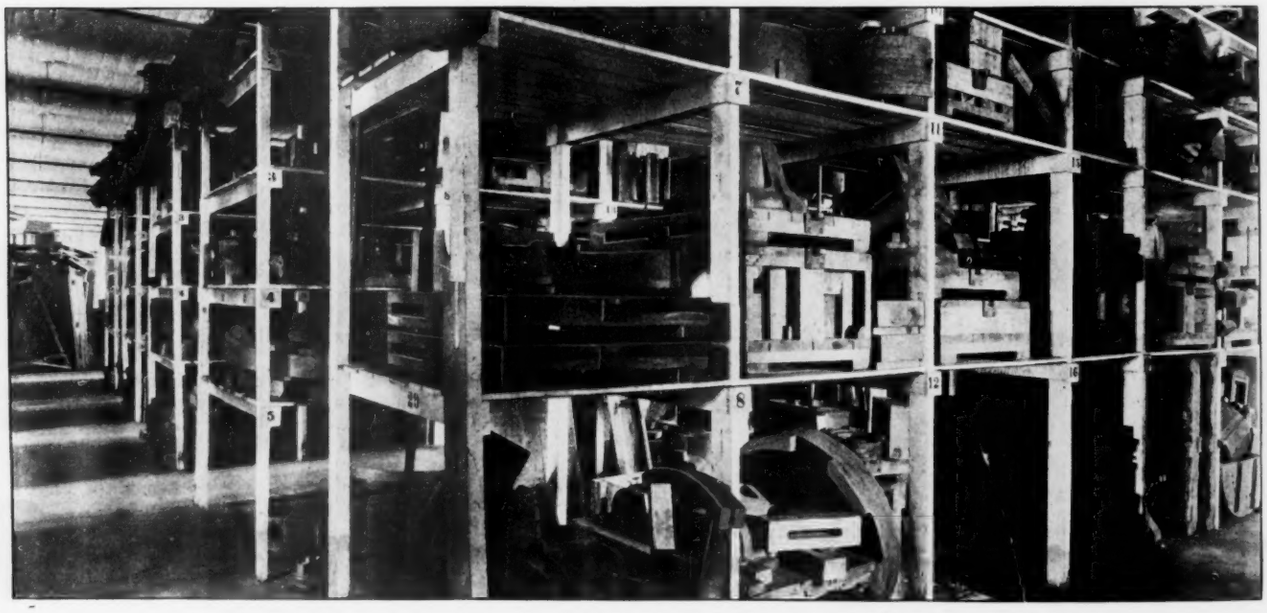


FIG. 4—PATTERNS OF MEDIUM SIZE ARE STORED ON NUMBERED RACKS

methods followed by a company which has successfully solved the problem should be of particular value.

The records maintained by the Cleveland foundry of the Westinghouse Electric & Mfg. Co. constitute a system which has proved highly successful in tracing the movement of patterns through the various departments of this extensive organization. The list of patterns, core boxes, pattern plates, and machine plates is so comprehensive and yet so simple that any one of over 50,000 pieces stored on seven floors of a large storage building may be found almost instantly by referring to the card file.

The present system is the development of a plan conceived when many of the castings used by the Westinghouse company were made at the old foundry at Allegheny, Pa., before the Cleveland plant was increased to its existing capacity. The original plan of numbering patterns provided for seven or eight series of 10,000 numbers, the numbers of each series having a letter prefix as *B*, *C*, *G*, etc. The numbers of each series were listed on 8 x 10-inch sheets bound in manila wrappers. Spaces were provided for marks to designate the location of the patterns in the storage racks, and for the dates on which the patterns were received from the pattern shop or sent to the foundry. When the Allegheny foundry was moved to Cleveland, the information on the sheets was transferred to a card file, the letter-prefix series being continued as before. Later another series with numbers running up to 50,000, and having no prefixed letter was started but before it was completed, the present scheme of numbering was adopted.

One of the disadvantages of the old systems, and the factor which prompted the change, was the existence of two complete and distinct sets of numbers for drawings and patterns. Under the old method of numbering, it was necessary to refer to a bulky volume of tracing numbers to determine the pattern shown on any particular blue print. If a pattern had to be replaced it was necessary to refer to a book to find out what blue print should be consulted. The inconvenience of this frequent procedure led to the adoption of the present series of pattern numbers.

The "six cylinder" series, as the new set of numbers is called, starts with 100,000. The pattern numbers correspond to the numbers of the drawings. For instance, if four patterns are shown on tracing No. 321,654, the patterns are numbered 321,654-A-1; 321,654-A-2; 321,654-A-3, and 321,654-A-4. When an alteration has been made in the tracing, the drawing number becomes 321,654-B,

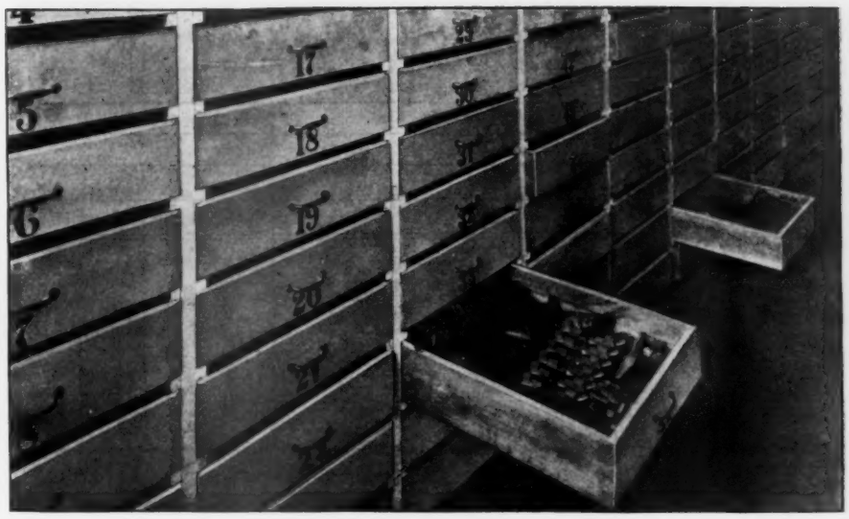


FIG. 7—SMALL PATTERNS ARE KEPT IN DRAWERS—SOME OF THE DRAWERS HOLD AS MANY AS 50 PATTERNS

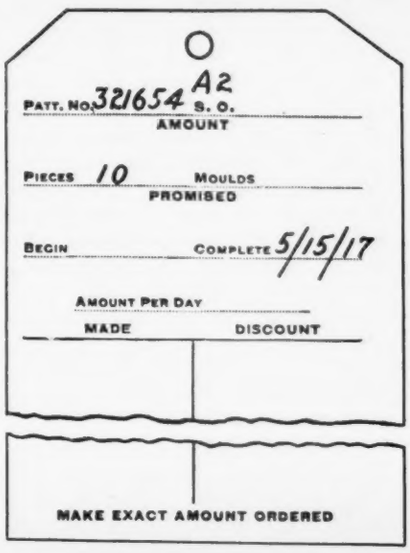


FIG. 8 — A TAG ACCOMPANIES EACH PATTERN TO THE FOUNDRY

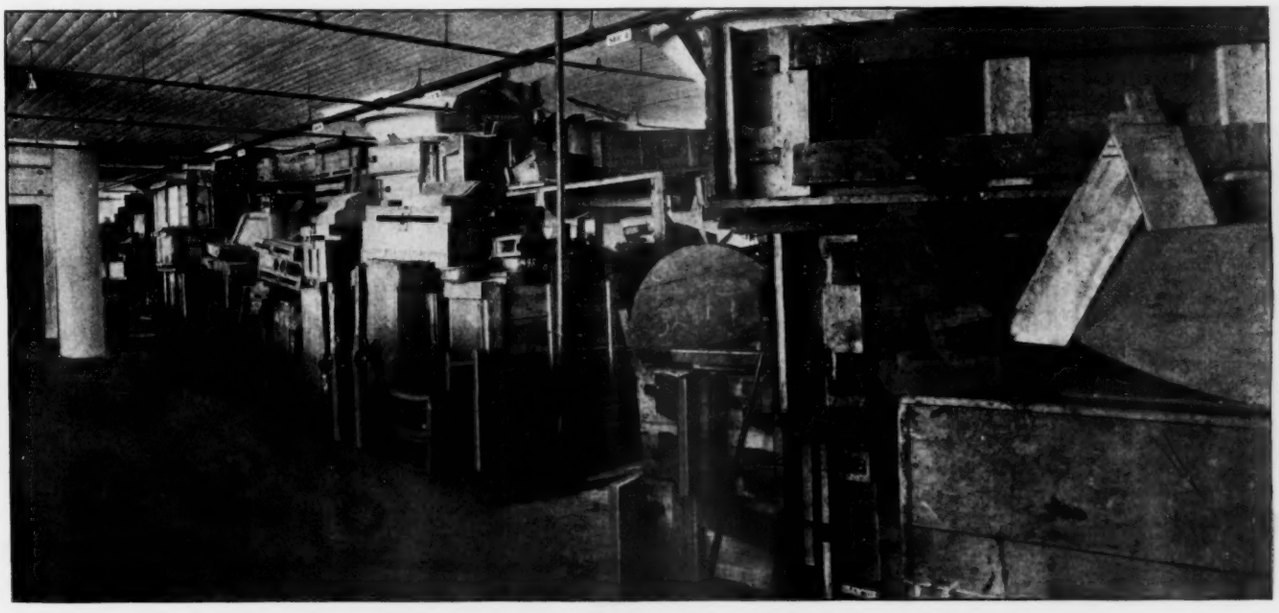


FIG. 6—LARGE PATTERNS AND CORE BOXES ARE GROUPED IN NUMBERED SECTIONS

	FLOOR	SECTION	RACK	SHELF
	3		12	23
PATT No. 321654-A-2	WOOD 1		MACHINE	
CONJ.	METAL		PATT. PLATE	
	ORIG.		FLASKS	
			CORE BOXES 1	
~~1-2-15~~				
~~3-6-15~~				
~~1-13-16~~				
~~2-27-16~~				
~~3-8-17~~				

FIG. 9—FACSIMILE OF A FILE CARD—THE INFORMATION ON A CARD INDICATES THE MOVEMENT OF THE PATTERN THROUGH THE VARIOUS DEPARTMENTS

and the patterns for the altered casting are 321,654-B-1; 321,654-B-2; etc.

The card index, which is the keystone of the system of records, is kept in cases in an office on the first floor of the pattern storage building and is conveniently near the point where patterns are delivered to and from the foundry. Each file case is plainly labeled with the lowest and highest number of the cards it contains. New cards are made out by the file clerk when he receives a memorandum from the engineering department at the East Pittsburgh office stating that certain drawings have been prepared. When the pattern shop receives authority to make a pattern, a notation to this effect is made in pencil on the card. When the pattern is completed and delivered to the storage department, it is accompanied by a memorandum, and the file clerk erases the pencil notation and marks the location of the pattern in the pattern storage department on the card in the space provided. This is shown in Fig. 9, which is a reproduction of the file card.

Patterns are stored on the first seven floors of the eight-story pattern building which was described in the April, 1916, issue of *The Foundry*. The small patterns which might easily be lost if stored on shelves are kept in drawers as shown in Fig. 7. Larger patterns are arranged on racks as illustrated in Fig. 4. Medium-sized patterns are kept on the second to seventh floors, while the extra large patterns, bulky core boxes and other heavy parts are stored on each of the seven storage floors. The stories are connected by two spacious elevators and two wide stairways. The arrangement of the floors is approximately as shown in Fig. 10.

In order to facilitate finding a given pattern, the racks are numbered according to the system indicated in Fig. 10. Each rack is divided into compartments known as shelves. The numbering of the shelves is shown in Fig. 4. The large patterns and core boxes are grouped in sections, and each section is marked by means of a painted sign suspended from the automatic sprinkler pipes near the ceiling as indicated in Fig. 6. Pattern plates for machine work are stored in racks on the first floor as illustrated in Fig. 1. Each slide in the racks is numbered by a painted metal tag. The file clerk is assisted in finding all of the pieces used with each pattern by notations on the card which show the number of cores, loose pieces, etc., required. An effort is made to store related patterns, coreboxes, and all other parts on one shelf or in adjacent shelves.

When more than one pattern is required to make a casting or when one of several patterns may be used to make a given casting, these facts are noted on the face of the card. This is an essential provision, for it is often possible to make one pattern take the place of another by simply using different cores. Each core box, and many of the patterns are stenciled with numbers to show the various pieces required to make up the entire pattern. This stenciling is shown in Fig. 5.

Referring again to the file card, Fig. 9, space is provided for showing the type of pattern used. After the words, "wood, metal, machine, pattern plate, flasks, core boxes" are spaces for inserting the number of each of these items. For instance, the card shown indicates that the pattern is of wood, that it is in one piece, and that one core box is used in making the casting.

When an order comes to the foundry for a casting, a triplicate copy of the order is sent to the file clerk. The order shows the number of the pattern, the number of castings to be made, and the date when the castings are to be completed. The clerk copies the pattern numbers into a book, and then by referring to his card file, marks the location of the patterns after each number in the book. Attendants then consult the book, go to the designated rack or section, and carry the pattern and necessary core boxes to a receiving point near the file clerk's office.

In the meantime, clerks in the main foundry office have made out tags similar to the one shown in Fig. 8. Each of these tags shows the pattern number, the number of castings to be made, and the date promised for completing

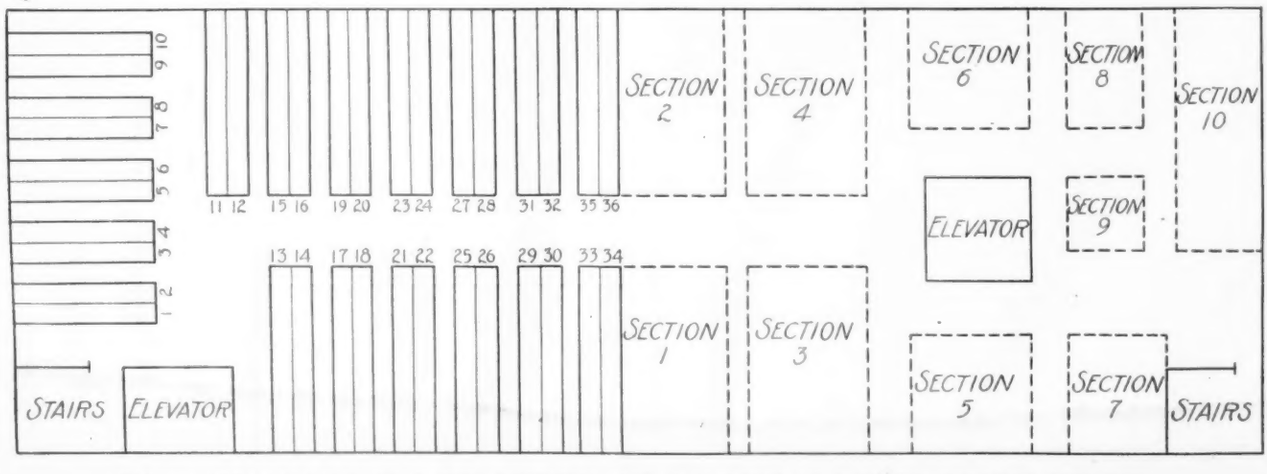


FIG. 10—ARRANGEMENT OF RACKS, SECTIONS AND ELEVATORS IN PATTERN STORAGE BUILDING

the castings. These tags are delivered to the file clerk, and as his assistants attach the tags to the patterns they have collected at the receiving point, the clerk writes the date in the space below the double line on the file card. The plain date indicates that the pattern was delivered to the foundry on the day indicated. When a pattern is sent to the pattern shop for repairs, a dotted line is drawn under the date. Thus the card shown in Fig. 9 indicates that the pattern was delivered to the foundry Jan. 2, 1915; March 6, 1915; Jan. 13, 1916; and March 8, 1917. It was sent to the pattern shop Feb. 27, 1916. If for any reason the pattern was shipped to the East Pittsburgh works, this fact and the date of shipment is noted. When a pattern is scrapped the word "scrapped" with the date of scrapping, is stamped on the face of the card, and the card is retained in the file to show the disposition of the pattern.

After the pattern has been used in the foundry, it is returned to the receiving point, and is accompanied by a memorandum from the foundry foreman. On receipt of the pattern, the file clerk refers to the card to find out the numbers of the core boxes and other pieces which belong with the pattern. His assistant then goes to the core room and collects the core box, and when all of the parts of the pattern have been collected, they are stored in the proper place in the storage rooms. The file clerk then draws a line through the date on the file card, thus indicating that the pattern has been returned and is again in its proper place on a certain floor of the storage building.

Experiments With Permanent Molds

By J J Howell

THE results of some important tests which were carried out in Herbert's Edgwick foundry for the purpose of making a definite comparison between gray iron cast in sand molds and gray iron cast in permanent molds will prove of interest to foundrymen. In carrying out these tests, three sets of test bars were used. The test bars were cast entirely from the same ladle of metal and as quickly as possible so as to eliminate any great change in temperature. The sand-cast bars were made in ordinary green sand molds. The permanent mold was of suitable design and was made of ordinary gray iron. The mixture used was an ordinary one, which is commonly used in the production of small parts for machine tools. In this instance it was made up of 600 pounds of Stanton No. 3 pig iron and 200 pounds of No. 1 Barrow hematite pig iron. The three sets of bars comprised bars cast in sand molds, bars cast in permanent iron molds, but not annealed, and bars cast in permanent iron molds and annealed. Chemical analyses were taken; transverse, tensile, Brinell and Keep's tests were made and microphotographs of each set of bars were taken.

Preparation of Test Bars

The transverse bars for the sand-cast samples were cast 1¼ inches square and 14 inches long. They were machined to exactly 1-inch square and were supported at 12-inch centers during the tests. The tensile bars for the sand-cast samples were cast 1¼ inches in diameter and 9 inches long and were machined suitable for a standard tensile-test bar. The bars for the tests of metal cast in permanent iron molds were made from sticks 1½ inches in diameter and 4 feet long; the annealed bars cast in permanent molds were annealed at a temperature of 800 degrees Cent. to 900 degrees Cent. for 20 hours.

In the transverse tests it was found that the bars cast in sand gave a breaking load of 2,250 pounds with a deflection of 0.130-inch. The bars cast in the permanent mold, not annealed, gave a breaking load of 2,325 pounds with a deflection of 0.110-inch, this being a slightly higher breaking strain with slightly less deflection than in the case of a sand-cast bar. The bars cast in permanent molds and annealed gave a breaking weight of 2,737 pounds with a deflection of 0.110 inch. Attention is called to the fact that although the sand-cast bars had a slightly greater deflection than those cast in permanent molds, the bar cast in the permanent mold and annealed stood no less than 23 per cent higher transverse strain than the sand-cast bars. With regard to tensile tests, it was found that the sand-cast bar stood 10.5 tons per square inch tensile strain. The bar cast in the permanent mold and not annealed stood 15.36 tons per square inch tensile strain, an increased strength, it will be noted, of 50 per cent over the sand-cast specimen. The bar cast in a permanent mold and annealed stood 15.6 tons per square inch, being slightly stronger than the unannealed bar. Under the Brinell hardness test, the sand-cast bar gave an average hardness of 175, the bar cast in the permanent mold and not annealed gave a hardness of 269, and the bar cast in the permanent mold and annealed gave an average hardness of 193. This test was very important indeed, as it indicates the wearing qualities of the metal.

It is readily noted that the metal cast in permanent molds, whether annealed or unannealed, is considerably harder than that cast in sand molds, and therefore had far better wearing properties. It was interesting to note, however, that although the metal cast in permanent molds is considerably harder than that cast in sand molds, it is much more easily machined. This, no doubt, is due to the fact that the combined carbon was more evenly distributed in metal cast in permanent molds. A cutting speed of 200 feet per minute was possible with this metal. Keep's test gave a shrinkage on a 12-inch bar, ½-inch square, of 0.138-inch, and a chill 1/16-inch deep, showing that the metal was such as could be used for small parts of machine tools. This test, however, proved that the mixture is not altogether suitable for casting in permanent molds, as it is most important for this purpose that a mixture which is practically non-chilling be used. But at the time of the test it was very difficult to obtain pig iron which would give a non-chilling mixture.

Chemical Constituents

The chemical analysis of the sand-cast bar is as follows: Total carbon, 3.313 per cent; combined carbon, 0.218 per cent; graphitic carbon, 3.095 per cent; silicon, 2.868 per cent; manganese, 0.506 per cent; sulphur, 0.057 per cent; phosphorus, 0.990 per cent.

In the bars cast in permanent molds and not annealed it was found that the only important change which had taken place chemically was that the combined carbon had increased from 0.218 per cent to 0.709 per cent, and that the graphite carbon had decreased from 3.095 per cent to 2.645 per cent. This, of course, is always to be expected in castings made in permanent molds and is due chiefly to the increased rate of cooling, which to some extent, prevents the carbon from separating out. In the annealed bar, however, a considerable change had taken place, the combined carbon

This paper was presented by the author, J. J. Howell, at the Dec. 9, 1916, meeting of the Birmingham branch of the British Foundrymen's Association.

being reduced to as low as 0.013 per cent while the graphitic carbon was increased to 3.300 per cent. This, of course, is accounted for by the annealing of this set of bars. But in this connection, a very important thing should be noted. The graphitic carbon in the annealed bar was exceedingly high and the combined carbon very low. In a sand-cast iron this would certainly give a very coarse fracture and a very weak iron, whereas the annealed bars cast in permanent molds were the strongest of the three sets and had the finest fracture. This is due to the graphitic carbon in iron cast in permanent molds being in an entirely different form from that in which it was found in iron cast in sand molds. Instead of being in large planes, it took the form of small particles very evenly distributed and perhaps it would be more correctly described as amorphous carbon.

With regard to the use of chills and permanent molds it must be distinctly understood that there is a great difference between the use of a densener and the use of a permanent mold. The use of chills locally simply accelerates and equalizes the cooling between a thick and a thin part of a casting, preventing porous patches and at the same time densifying the metal at this particular point. With a permanent mold, the advantage of the chill is received so far as the accelerated cooling of the metal is concerned. But the most important function of the permanent mold is that by its use an enormous amount of compression is put on the plastic casting, due to the expansion of the casting at its recalescent point. This expansion, of course, is turned into a compressive force by the use of the permanent molds.

It is not feasible to make all sorts of castings in permanent molds. A great deal, of course, depended on the shape of the casting required. But there are a large number of castings used which are difficult to cast satisfactorily in sand molds. Some of these could be made in permanent molds without any sign of unsoundness.

The experiments seem to indicate very clearly that not only should chills be used to equalize the cooling strains between thick and thin parts of castings, but wherever possible permanent iron molds should be used for the production of castings which are required to be exceptionally strong and dense.

According to statistics and estimates received by the United States Geological Survey, the output of blister and Lake copper from domestic ores in 1916 was 1,928,000,000 pounds, against 1,388,000,000 pounds in 1915 and 1,224,000,000 pounds in 1913. At an average of about 27 cents a pound, the output for 1916 was valued at $520,000,000, compared with $242,900,000 for 1915 and $189,790,000 in 1913.

Bethlehem Makes Large Iron Mold for Guns

What is claimed to be the largest octagonal, corrugated ingot mold ever made in this country was cast recently in the steel foundry of the Bethlehem Steel Co., South Bethlehem, Pa. The mold is 15 feet 7 inches in height and has a mean diameter of 91½ inches. At the thinnest section, or point of corrugation, the thickness of the metal is 15 inches, while the thickness of the heaviest section is 20¾ inches. Owing to the necessity of pouring this casting very quickly, it was made in the steel foundry rather than in the iron foundry. After finishing the mold, which required four weeks to prepare, standard bessemer iron, melted in three open hearth furnaces, was poured into ladles which were suspended over the mold simultaneously, and a continuous runner from these ladles was constructed, so that the iron was thoroughly mixed before entering the mold. The metal originally charged into the furnaces amounted to 340,000 pounds and after the mold had been filled, an additional 10,000 pounds was brought from the iron foundry, located three-quarters of a mile away, to pour into the sinkhead to take up the shrinkage. The added metal was filled in about a ton at a time for three hours, when the shrinkage stopped; the metal, however, remained liquid five hours after the mold was poured. The mold was left covered for some time and after shaking-out it was lifted from the pit by two large 100-ton cranes. The mold is to be used in making the tubes and jackets for large-sized guns. Before the mold can be used, large steel bands, 8 x 12 inches, must be shrunk around each end of the casting.

Chilled Castings from a Cupola Running Gray Iron

By W. J. Keep

Question:—We are trying to melt gray iron in a cupola, which by the use of an iron chill in certain parts of the mold will give a chilled surface approximately 1/16 inch deep and at the same time we desire to have the metal machinable in the unchilled sections. To obtain these results, we probably will have to run a mixture containing .1 per cent silicon or less and above 3 per cent carbon. We would like to know just what our mixture analysis should be. In making your recommendations, we would be glad to have you state the percentages of various grades of raw materials to be used and the complete analyses of the pig iron recommended. How can the foregoing mixture be obtained without the use of car wheel scrap?

Answer:—You will not have to use a special iron to get a 1/16-inch chill, neither will you have to employ a very low silicon iron. You can readily purchase a coke iron with a chilling tendency. However, you failed to state from what portion of your heat you wish to tap the chilling iron. If you desire to produce only a small number of such castings with the remainder soft, charge 10 per cent of steel punchings in the cupola with one of the charges, or you can place in the ladle, before catching the iron, a quantity of light steel castings which will be melted by the iron running over it. A piece of sulphur placed in the ladle, will impart a chill to that ladle of iron. Also, you can accomplish this same result by keeping the silicon low in as many charges as are required to produce the castings that are to be chilled. To produce a chill 1/16 inch thick, you will not require very low silicon when using chillers in the mold. The silicon is all that you will have to regulate. From the company furnishing you pig iron you can obtain analyses of each carload and with these analyses and that of the iron which you have, you can readily calculate the silicon requirements. For regular chilled castings, such as the rims of wheels, some brands of pig iron naturally produce a chill, regardless of what the silicon may be and most brands of charcoal iron will accomplish this. Ordinary car wheel scrap also is good for this purpose. For making car wheels, a large number of manufacturers use steel scrap, which helps to impart the necessary chill.

The Steel Treating Research Club, of Detroit, has acknowledged the receipt of an unsolicited contribution of $100 from Sir Robert Hadfield, of London. He has also prepared a discussion of Harvard J. Stagg Jr.'s paper on impact tests recently presented at a meeting of the Steel Treating Research Club. A paper on "Advances in Metallurgy of Iron and Steel", now being prepared by Sir Robert Hadfield, will be available in a few months.

William N. Gartside, president of the Diamond Clamp & Flask Co., Richmond, Ind., died on Sunday, March 4.

Modern Methods of Melting Non-Ferrous Metals

Results of Recent Experience Discussed in Series of Papers Presented at March Meeting of British Institute of Metals

Summary of Papers Presented at Institute of Metals

A symposium of papers on the melting of non-ferrous metals was presented at the annual meeting of the Institute of Metals, held at London, Eng., March 21 and 22. The developments that have taken place as the result of recent experience, were discussed from the viewpoint of the acceleration of output and efficiency of operation. "Metal Melting as Practiced at the Royal Mint," was the subject of a paper presented by W. J. Hocking, London, which discussed the melting and casting into bars for coinage, of standard gold, silver, bronze and cupro-nickel. These castings are of comparatively small dimensions and are in the form of thin, rectangular strips, about 2 feet long, varying in width and thickness. Until 1910, coke furnaces were used, but as the result of a series of experiments, furnaces fired by low-pressure gas and air are employed.

G. B. Brook, of Sheffield, discussed "Coal Gas as a Fuel for the Melting of Non-Ferrous Alloys." The results of experiments made at the University of Sheffield, which showed the material advantages of gas over other fuels for melting non-ferrous alloys, were presented. H. M. Thornton and H. Hartley, London, read an interesting paper entitled, "The Melting of Brass and Copper in a Crucible Furnace With Coal Gas Fuel." It was pointed out that the life of pots obtainable in gas-fired furnaces is greater than in coke-fired furnaces, and the time required for the melt is less than in furnaces using solid fuel. Also, marked fuel savings result when the furnace is designed so that the metal is preheated before admission to the blast furnace.

Other papers presented, include the following: "Ideals and Limitations in the Melting of Non-Ferrous Metals," by Carl Hering, Philadelphia; "Metal Melting in a Simple Crude Oil Furnace," by H. S. Primrose, Ipswich, Eng.; "Annealing Nickel Silver," by F. C. Thompson, Sheffield; "The General Properties of Stampings and Chill Castings in Brass of Approximately 60-40 Composition," by W. Ellis, London; "Aluminum Production by Electrolysis," by R. Selegman, London, and "Surface Tension and Cohesion in Metals and Alloys," by Sydney W. Smith, London. Summaries of a number of the papers which were presented at the meeting appear on the following pages.

Melting Brass in a Gas-Fired Cupola Furnace

By H M Thornton and H Hartley

THE marked success achieved by furnaces employing coal gas as a fuel, in the heat treatment of metals such as steel, is proving of material assistance in the introduction of gas-fired, metal melting crucible furnaces. It is proposed, in this paper, to deal only with a furnace of the type intended for melting the metals of higher melting point, from brass upwards.

In working with coal gas the fact must not be overlooked that in terms of B. T. U. available the fuel is costing from four to five times as much as coke, assuming the gas supply to give 500 B. T. U. per cubic feet net at a cost of 2s per 1,000 cubic feet, and even with water gas the fuel is considerably more costly per B. T. U. than the coke which it is intended to replace. Starting with this disadvantage the furnace manufacturer has either to obtain a markedly greater thermal efficiency out of his appliance, or to effect economies in other directions.

When asked to quote fuel consumptions, the furnace manufacturer will not be able to do so unless the melter can provide some fairly precise information as to the pouring temperature required. In the authors' work with brass and copper the pouring temperature has ranged about 100 to 150 degrees Cent. above the liquidus. In this connection it is of interest to recall the work of Mr. Lohr, in which the conclusion is drawn, after an examination of the copper-zinc alloys, that the best pouring temperature is between 100 and 200 degrees Cent. above the liquidus, a higher pouring temperature always producing an oxidized casting. With reference to brass melting, overheating is not advisable, as there is always the danger that it will lead to honeycombing if the metal is cooled before pouring.

Brass Melting

Starting from cold the additional fuel needed acts as a handicap in the endeavor to obtain low average consumptions, the overall effect of which is decreased by increasing the number of melts carried out successively. For the fourth and subsequent melts it is found generally that the gas consumption per pound of metal melted remains practically constant. In the last melt of the day a small saving is effected, owing to the fact that there is no excess of brass in the metal preheating chamber, and in consequence the degree of preheating of both the metal and air increases.

In the accompanying table are given results of a typical run, limited to six melts to avoid repetition, and added are the average consumptions on the basis of 12, 15 and 20 melts.

	Gross consumption per lb. metal melted, cu. ft.	B. T. U. per lb. metal melted.
Average for 6 melts...	2.25	1,203
Average for 12 melts...	1.92	1,031
Average for 15 melts...	1.86	996
Average for 20 melts...	1.79	962

Analyses of two brasses remelted several times (*a*) with a sawdust covering, (*b*) with common salt as a flux, indicate that the loss of volatile constituents is much the same even when

the metal is rendered very hot. There is a certain amount of inconvenience attached to working with a salt covering, owing to the acid fumes produced. On the other hand, salt is stated to be useful in small quantities, admixed with charcoal to prevent absorption of sulphur by molten copper and its alloys, and to lessen the retention of viscid metal by the dross. The fluxes used more generally are calcium fluoride, glass and potassium hydrogen sulphate. The authors incline to the view that the most satisfactory results are obtainable by the use of a charcoal or similar covering, together with a small amount of flux. In an inert atmosphere the rate of loss of zinc from a given brass will depend on the temperature and the speed of flow of the gases over the metal. During melting the process may be accelerated owing to the oxidation of the zinc vapor and consequent reduction of the partial pressure of the metallic vapor. The effect of this latter factor is decreased to some extent if the combustion of the gases is not completed in the pot chamber, and still further if a covering of charcoal is employed. In the final heating stage, after the metal is molten and when the greatest loss occurs, a crucible lid previously heated in the metal preheating chamber can be used to cover the pot and decrease the loss.

Assuming that it requires in the respective furnaces 3.0 cubic feet of coal gas, or 0.5 pound of coke per pound of metal melted; then if the gas is burnt completely to CO_2 in the pot chamber, the volume of products (calculated at 0 degree Cent. and 760 mm.) will be about 14 cubic feet, whereas with the coke if it burns to CO_2 there would be about 77 cubic feet of products, and if only CO were formed, about 45 cubic feet. From three to five times the volumes of products flowing through the gas-fired furnace pass through the coke furnace.

Zinc Losses

The authors have investigated the question of zinc losses in connection with gas-fired furnaces. In making up a red brass containing a little tin in four 50-pound lots, they found the average zinc loss not to exceed 3 per cent. With regard to the zinc loss on remelting yellow brass, the following tests were made: Two 70-pound lots of works scrap brass A and B were melted and cast into chills, sample ingots being retained for analyses. Batch A was then remelted with a covering of sawdust only, cast into ingots, a test ingot withdrawn, and the remainder returned to the crucible, remelted, and a further sample taken. This treatment was repeated, five remelts in all being made. In the last melt, after the pourers had approved the metal to be sufficiently hot for casting purposes, the crucible was left in the furnace for another half-hour, the temperature of the metal being raised steadily during the whole of this period. The second batch of metal B was treated in a similar manner, except that in this case a covering of common salt was employed, and no provision of charcoal made for the prevention of oxidation. In neither case was a crucible lid used. The test ingots weighed about 3 pounds each. As a result of these tests it was found that with a low pouring temperature, that is, 1,000 degrees Cent., the loss of zinc need not exceed 1½ per cent of the zinc originally present. With a red brass poured at 1,090 degrees Cent., the loss was somewhat higher, while when the temperature of a yellow brass was raised to 1,180 degrees Cent., the zinc loss rose to about 6 per cent.

Melting tests with copper proved how important it was to load up the pot as much as possible if the most economical melting is desired. Materially better results were obtained when the charge was mixed scrap and ingots than when only sheet scrap was handled.

Thermal Efficiency

From the results given for brass, combined with those obtained with copper, it is possible to arrive at an estimate of the additional gas consumption necessary to heat the brass to a considerably higher temperature. If it be assumed that the specific heat of brass is the same as that of copper (at ordinary temperatures this is very nearly so), and that the heat allowance to be made for the liquefaction of the brass is 152 B. T. U. per kilogram; then the steady state efficiency during the fifth brass melt (metal poured at 990 degrees Cent.) will be 30 per cent. Over-all efficiency for six brass melts (990 degrees Cent.) will be 21.3 per cent. To get the brass to 1,090 degrees Cent. would require about 1,456 B. T. U. per pound. With an increased number of melts the actual extra gas used on the basis of the average for the day's work decreases, but still remains about 20 per cent more than that required for 990 degrees Cent. As regards copper, with 560 B. T. U. gas the six melts were made at an average consumption of 2.25 cubic feet per pound gross, equal to 1,200 B. T. U. per pound of metal melted, from which it would appear that, roughly, the thermal efficiency of the gas furnace is about five times that of many coke furnaces, the latter converting approximately 4 per cent of the available energy into useful work.

The results were obtained by the authors in a gas-fired furnace, with an arrangement for pre-heating the metal prior to charging and for pre-heating the air supply before it was admitted to the blast burner. A simple calculation shows that pre-heating can effect a considerable saving of fuel. In actual practice with brass the following results were obtained, pouring at about 1,000 degrees Cent.:

No. of melts made consec....	4	6
	Gas consumption per lb. of metal melted.	
No preheating (*a*).....	3.10	2.91
Brass preheated (*b*).....	2.72	2.48
Brass and air preheated (*c*)..	2.42	2.17

The actual consumption in cubic foot per pound for the fourth melts were: (*a*) 2.52; (*b*) 1.99; (*c*) 1.66. Thus it is evident that for brass melting the most suitable type of furnace to be employed will depend upon the number of melts required daily, as when only a few melts are required the additional capital cost involved in the introduction of the pre-heating device may not be compensated for adequately by the gas saved.

A well-made graphite crucible is capable of withstanding very sudden temperature changes to an almost surprising extent. According to Mr. Downs, in actual commercial use for melting purposes a crucible has been known to stand from 80 to 100 charges in melting copper or a similar metal. Many melters, however, only claim about 30 melts per pot. In a gas-fired furnace the abrasive action of the solid fuel is eliminated, the direction of flow of the gas stream is under better control, the sulphur content of the fuel is very small (about 30 grains per 100 cubic feet), there is no fire to poke, and clinkers do not have to be removed from the outside of the pot, so that it is not surprising that long pot lives can be obtained, especially in the absence of fluxes, or with a flux which does not attack the crucible walls viciously.

The average time for the actual melting operation for 12 melts of 68 pounds each, is 30 minutes, and for 15 melts, 37 minutes, making no allowance for the time required to pour. Under similar conditions 55 minutes would probably represent an average for many coke-fired furnaces. It should be noted, however, that the authors' results for gas consumptions have all been obtained in the works of the Richmond Gas Stove & Meter Co., by members of their staff, and are not to be regarded as representing *works practice*, as ordinarily understood.

Description of Furnace

The metal melting referred to has all been carried out in a Richmond 70-pound crucible furnace of the pre-heating type. The gas and air mixture is admitted through a suitable blast burner and the lower portion of the combustion chamber, and is burnt in the annulus between the crucible and the furnace wall. The gases, after traveling around the pot, are directed through the metal pre-heating chamber, and then pass on

THE FOUNDRY DATA SHEET, MAY, 1917

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

MELTING POINTS OF THE CHEMICAL ELEMENTS

From Circular No. 35, United States Bureau of Standards, 1915

Element.	Cent.	Fahr.
Helium	−271	−456
Hydrogen	−259	−434
Neon	−253?	−423
Fluorine	−223	−369
Oxygen	−218	−360
Nitrogen	−210	−346
Argon	−188	−306
Krypton	−169	−272
Xenon	−140	−220
Chlorine	−101.5	−150.7
MERCURY	− 38.9	− 38.0
Bromine	− 7.3	+ 18.9
Caesium	+ 26	79
Gallium	30	86
Rubidium	38	100
Phosphorus	44	111.2
Potassium	62.3	144
Sodium	97.5	207.5
Iodine	113.5	236.3
Sulphur S_I	112.8	235.0
Sulphur S_{II}	119.2	246.6
Sulphur S_{III}	106.8	224.2
Indium	155	311
Lithium	186	367
Selenium	217–220	422–428
TIN	231.9	449.4
Bismuth	271	520
Thallium	302	576

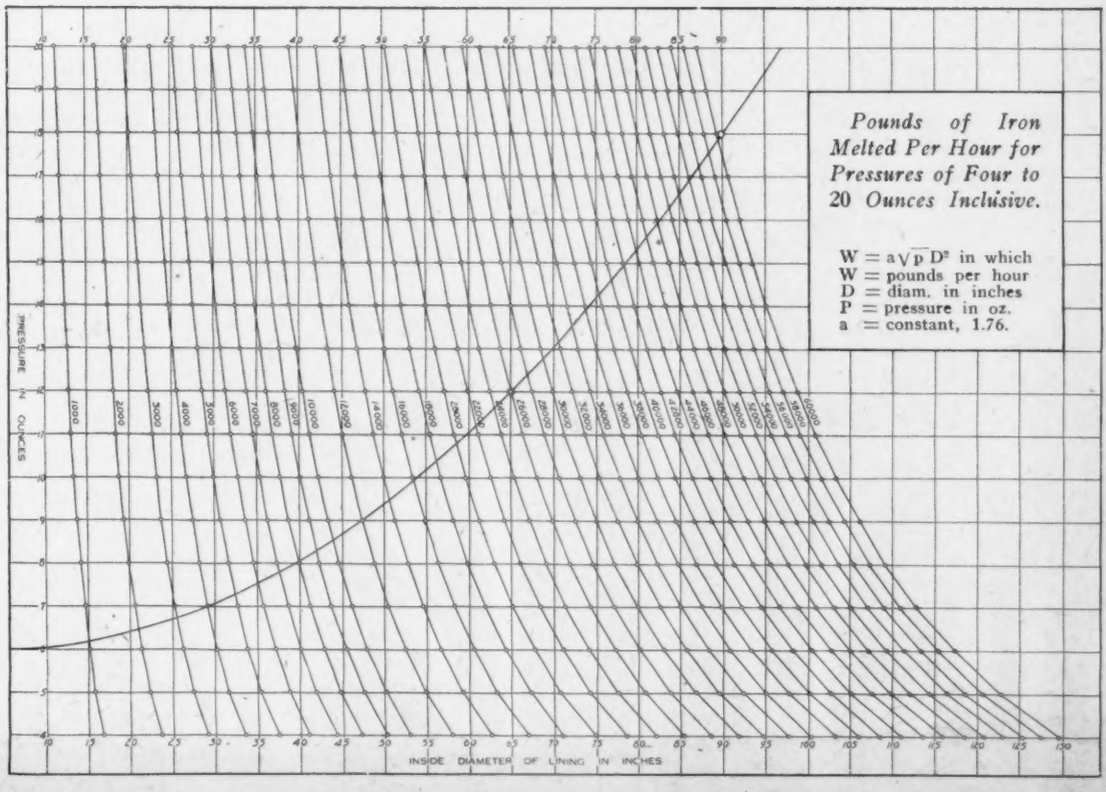
Element.	Cent.	Fahr.
CADMIUM	320.9	609.6
LEAD	327.4	621.3
ZINC	419.4	786.9
Tellurium	452	846
ANTIMONY	630.0	1,166
Cerium	640	1,184
Magnesium	651	1,204
ALUMINUM	658.7	1,217.7
Radium	700	1,292
Calcium	810	1,490
Lanthanum	810?	1,490
Strontium	Ca Ba?	.....
Neodymium	840?	1,544
Arsenic	850?	1,562
Barium	850	1,562
Praseodymium	940?	1,724
Germanium	958	1,756
SILVER	960.5	1,761
GOLD	1,063.0	1,945.5
COPPER	1,083.0	1,981.5
Manganese	1.260	2,300
Samarium	1,300–1,400	2,370–2,550
Beryllium (Glucinum)	1,350?	2,462
Scandium	?	.....
Silicon	1,420	2,588
NICKEL	1,452	2,646

Element.	Cent.	Fahr.
Cobalt	1,480	2,696
Yttrium	1,490	2,714
Chromium	1,520	2,768
IRON	1,530	2,786
PALLADIUM	1,549	2,820
Zirconium	1,700?	3,090
Columbium (Niobium)	1,700?	3,090
Thorium	1,700 Pt.	3,090 Pt.
Vanadium	1,720	3,128
PLATINUM	1,755	3,191
Ytterbium	?	.....
Titanium	1,800	3,272
Uranium	1,850	3,362
Rhodium	1,950	3,542
Boron	2,200–2,500?	4,000–4,500
Iridium	2,350?	4,262
Ruthenium	2,450?	4,442
Molybdenum	2,500?	4,500
Osmium	2,700?	4,900
Tantalum	2,850	5,160
TUNGSTEN	3,000	5,430
Carbon	3,600 for p = 1At.	6,500 for p = 1At.

THE FOUNDRY, DATA SHEET NO. 233, MAY, 1917.

AVERAGE OUTPUT OF CUPOLAS

By F. A. Coleman


Pounds of Iron Melted Per Hour for Pressures of Four to 20 Ounces Inclusive.
W = a√p D² in which
W = pounds per hour
D = diam. in inches
P = pressure in oz.
a = constant, 1.76.
PRESSURE IN OUNCES
INSIDE DIAMETER OF LINING IN INCHES

THE FOUNDRY, DATA SHEET NO. 234, MAY, 1917.

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

to the air pipes, and finally to the flue. This arrangement enables a high degree of preheat of the metal to be obtained. The top of the metal chamber is on a level with the top of the pot chamber, and is closed by a pair of lids. With this construction the operator does not have to lift his metal above the foundry floor level, and the transference of preheated material to the crucible is accomplished with ease. The lower portion of the wall of the combustion chamber is constructed of suitably shaped blocks of a specially refractory nature to enable greater resistance to be offered to the combined action of high temperatures and split metal. The bottom of the chamber can be removed.

Melting Practice at the Royal Mint

By W J Hocking

STANDARD gold, silver, bronze and cupro-nickel are melted at the mint and cast into bars for coinage. The castings are of comparatively small dimensions, and are in the form of thin, rectangular strips about 2 feet long, varying in width and thickness.

In melting precious metals for coinage work, the correct proportions of the gold-copper and silver-copper alloys must be maintained within the restricted limits of variation prescribed by law. For this reason the volume of the charge is limited to one which can be conveniently stirred and manipulated with a view to the production of bars uniform in composition. For gold the weight of the charge is 2,800 ounces, for silver about 6,000 ounces, and for bronze and cupro-nickel about 400 pounds.

Coke furnaces were in use until 1910. The melting department was then enlarged and rebuilt, and, as the result of a series of experiments, furnaces, fired by low-pressure gas and air, were introduced. Urgent demands for coinage arose, and during the rebuilding operations an improved gas-melting plant was installed, with a floor space of 860 square feet only. In the course of a year and nine months 874 tons of standard gold were melted. As a test of the efficiency of the four experimental furnaces in use, a continuous run of melting was maintained for 27¾ hours. The total amount of gold melted was 257,052 ounces, or 7.87 tons. There were 102 pourings, and the consumption of gas was 32,000 cubic feet. The furnaces were in a condition to resume work on the following day as usual.

New Furnaces for Melting Silver and Bronze

The larger of the two new rooms for melting operations was completed before the close of the probationary period in the blacksmith shop and work was commenced therein in January, 1911. Sixteen furnaces are constructed in line near the center of the room, divided in two batteries, one of 10 and one of six. The furnaces are built of fire brick, each well being

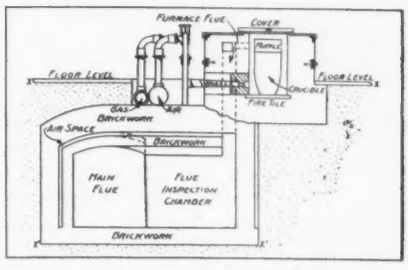


FIG. 1—SECTIONAL ELEVATION OF FURNACE

19 inches in diameter and 32 inches deep. The wells are lined with circular bricks, 3 inches thick, jointed with a refractory material composed of carborundum, firesand and silicate of soda, which is also used as a backing for the bricks. The face of the bricks forming the interior of the wells is treated with a wash made up of the same materials. The whole mass of brickwork is braced together by a framework of iron bars to resist expansion, but is not enclosed with iron casing. For convenience the furnaces stand 27 inches above the floor level. The tops are covered with cast iron plates 1 inch thick, bedded upon a ½-inch layer of asbestos cement. The plates are fitted loosely in sections to admit of expansion, and are shaped to allow a lip of brickwork around each furnace hole, 4½ inches broad. This ring of brickwork is made to rise slightly above the level of the iron tops, and serves to prevent the fusion of the iron coverings. The tops were at first carried to the edge of the furnace holes, and the molten iron scored the face of the furnace linings, necessitating frequent renewals. A circular fire brick, 27 inches in diameter and 3 inches thick, is used to close the mouth of the furnace hole during melting. This cover is surrounded by two semi-circular iron bands, ¾-inch thick,

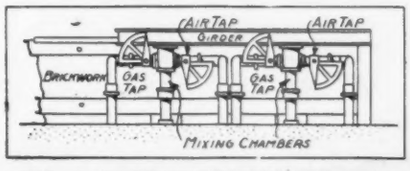


FIG. 2—BACK ELEVATION OF TWO FURNACES

bolted together to form a frame. The cover, which weighs 150 pounds, is lifted and wheeled into any desired position on the furnace top by means of a specially-designed truck.

An electrically-driven overhead traveling crane of 500 pounds capacity hoists the crucible of molten metal from the furnace, and transports it to one of two pouring frames. The movements of the crane are directed by means of switches situated at two platforms. When in position for pouring, the crucible is gradually tilted by worm gearing connected with the frame through a quadrant, and the contents poured into iron molds. The molds are set up in batches of about 40 in wheeled carriages which travel on a permanent track laid lengthwise of the room with a turntable and side-track at one end. During the process of pouring, the forward motion of the carriage on the rails as the molds become full, as well as the upward movement of the crucible, is secured by rack and pinion gearing attached to the frame, the motions being actuated by separate wheels, controlled by two workmen.

Fuel Supply and Combustion

Experience gained with the use of gas fuel in the temporary gold-melting house pointed to the desirability of securing a liberal supply of gas at a constant pressure. The supply of gas under these conditions was undertaken by the gas company. In the large house the gas is delivered at the furnaces at a steady pressure of 3 inches of water at the furnace. As the total consumption of the 16 large furnaces is about 15,000 cubic feet per hour, the provision for delivery is well in excess of the requirements. An ample reserve is considered essential to uniformity in results.

Three rotary blowers of the Reichhelm type are used to supply air for the burning mixture. Each blower is capable of delivering 36,000 cubic feet of free air per hour at 2½ pounds pressure. All the pressure blowers are motor-driven, and two are coupled to feed the larger battery of 10 furnaces. The maximum horsepower required to supply air under pressure

for the whole of the furnaces in the large room is 45. The air and gas are supplied by pipes laid below the ground level in a trench running parallel with the back of the furnaces. The sizes of these pipes are sufficiently large to admit of one or more furnaces being thrown in or out of action without disturbing the steadiness of the supplies to the remainder; that for air is 9 inches, and that for gas is 5 inches to the larger battery and 4 inches in diameter to the smaller. Connecting pipes from each of the two services are attached to a horizontal girder for support, and conduct the air and gas into a Brayshaw mixer. The pressures are 3 inches for gas and 2½ pounds for air. Check gages are in use to see whether these pressures are obtained at the furnaces.

Furnace Construction

Fig. 1 is a sectional elevation of the furnace, showing the crucible, muffle and cover, the gas and air pipes with nozzle and burner brick in position, and the main flue with its connections. Fig. 2 is a back elevation, showing the gas and air pipes with quadrant taps, and the girder support.

Fig. 3 shows a plan of two furnaces without their covers, each containing a crucible. One shows the top view with flue, and the other the bottom with nozzle and burner block. The admission pipes to the mixing chamber are fitted with valves, the levers of which move over a graduated quadrant. With well-constructed taps of this description the supply of gas and air can be regulated with precision. In the course of a heat these supplies require adjustment as the temperature rises in the furnace. From the mixing chamber the gaseous fuel passes through a right-angle elbow pipe, 2½ inches in diameter, to the furnace. To adjust the length of flame to the capacity of the furnace and secure greater melting efficiency, the internal diameter of this pipe was reduced at its extremity to 1¾ inches. The method of inserting the nozzle of the burner into the wall of the furnace, illustrated in Fig. 4, is the one yielding most satisfactory results. An 8-inch end-piece, screwed in position and having a diminished bore, forms the nozzle, which is increased to 4 inches in outer diameter at its extremity. It is easily detached and renewed in the event of corrosion or partial fusion.

The ignition hole of the furnace consists of a perforated fire brick of special shape as shown in the sectional drawing given in Fig. 4. A circular recess, 4 inches in diameter, at

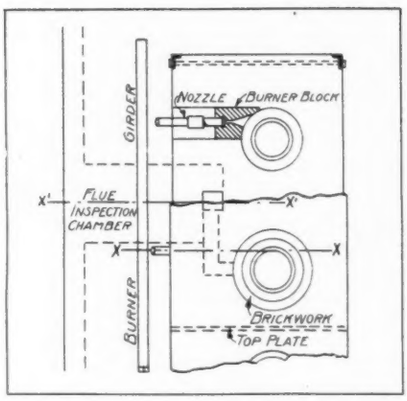


FIG. 3—PLAN OF TWO FURNACES

the back of the block, which is 9⅛ inches square on the face, receives the iron nozzle which fits the recess closely, and is surrounded by asbestos packing well rammed in. The comparatively large block of fire brick serves to keep the nozzle relatively cool. At the bottleneck the inlet is 1¾ inches in diameter, corresponding with the bore of the burner. The passage then opens out at an angle of 30 degrees into the well of the furnace. The burner block is set to one side of the horizontal axis of the furnace well into the brickwork in a position to induce the flame to pass between the crucible and the side of the furnace without impinging upon either. The crucible is placed centrally in the furnace upon a graphite stand, 10 inches in diameter and 2¼ inches thick. A plumbago muffle or collar, 8 inches deep, rests on the crucible to increase its initial capacity, but no cover is used for the charge during melting in the case of silver and the baser metals. About 3 inches clear space is allowed around the crucible at its greatest diameter to admit of the lowering of the tongs which lift it from the furnace for pouring. When the furnace is closed the top of the muffle is within 2 inches of the cover.

The gas flame on leaving the ignition hole travels round the crucible in an upward double spiral. The best results in economy and efficiency are obtained when combustion is complete in the furnace itself, no flame being emitted under the furnace cover nor carried into the flue aperture. To reduce the length of the flame, which grows as the temperature in the furnace rises during the progress

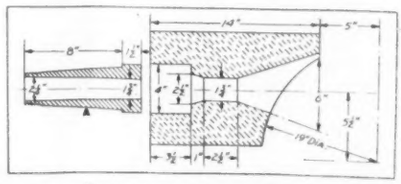


FIG. 4—FIRE BRICK BURNER BLOCK; THE GAS BURNER NOZZLE IS SHOWN AT *A*

of the melt, the supply of gas and air is reduced. The flue aperture is 4 x 2 inches in sectional area, with its axis 5 inches below the iron covering plates, and opens into a horizontal duct leading from the furnace to a vertical shaft, 6 inches square, which serves two furnaces, and is connected with the main flue below the floor level. The main flue before entering the chimney shaft passes through a condensing chamber provided with baffles to intercept any solid matter carried off by the flue gases.

For the prevention of accidents in the use of the large volumes of gas and air delivered to the furnaces, a recognized system of workshop procedure was necessary. The following routine works satisfactorily. All the air valves are opened, and the blower is then started to deliver air to the furnaces. Then, dealing with each furnace successively, the air valve is closed, the gas valve opened, the gas ignited, and the air valve reopened to its utmost capacity. So soon as the whole series of furnaces is alight, the gas and air taps are adjusted to produce the proper burning mixture in each case. In shutting off a single furnace the gas valve is first closed and then the air. When dealing with the whole battery, the gas valves are closed on all the furnaces, the pressure blower stopped, and the quadrant taps turned off. Should the blower stop unexpectedly through a breakdown all gas and air taps are closed immediately. In view of this emergency the air pipes are, in some cases, provided with non-return valves which are automatically brought into action as soon as the pressure ceases. Experiments are in progress to devise a simple and effective form of safety gear for such a contingency.

Caring for Linings

The furnace linings receive close attention, which is repaid by a lengthened life. The surfaces are kept free from excrescences which would obstruct the free passage of the flame. Accumulations of slag at the bottom of the furnace are cleaned out at frequent intervals. Faults in the brickwork are patched immediately. As a general result the entire lining of a furnace is renewed two or three times a year.

Provision is made for the ventilation of the melting house by three Blackman fans, placed one at each end and one at the side, near the roof. These can be used either for supply or exhaust, as required. If two of the fans are drawing from the room, and one is discharging into it, the

whole volume of air is changed every five minutes, independently of the doors, windows and skylight.

Comparison of Costs of Melting

Records are kept in the department of the results of melting with gaseous fuel for comparison with similar results obtained with coke. These results are available for a period of five complete years, both for gas and coke. During the five years, 1911-16, nearly 10,000 tons of metal were melted and cast into bars for coinage with a total consumption of 121,000,000 cubic feet of gas. A comparison of the records for the two periods shows an economy in favor of gaseous fuel under each of the following heads: (1) Rate of output, (2) cost of fuel, (3) cost of graphite goods, (4) cost of labor.

(1) *Rate of Output.*—Except for gold, crucibles of the same capacity as formerly were used, but the time required for the heats was shortened considerably. The rate of output per furnace in the working day was correspondingly increased, and this increase was especially noticeable in the case of bronze, 157.7 per cent, and cupro-nickel, 161.1 per cent.

(2) *Cost of Fuel.*—The respective costs of coke and gas vary considerably in different localities. They are also liable to vary in the same locality during a given period. During 1905-9 the price of best foundry coke delivered broken for use at the Mint fluctuated from from 35s to 42s 4d per ton; while during 1911-16 the discount price of gas per 1,000 cubic feet varied only very slightly from 21d, except during nine months of 1915-16, when it was 18.2d. Although the price of gas advanced 12½ per cent during the last five years, the net cost to the Mint remained practically stationary owing to the sliding scale of discounts allowed by the gas company. On the total expenditure for fuel for the two periods of five years a cash saving of 3½ per cent on the amount consumed per ton melted is shown for 1911-16. The amounts melted and the fuel consumed for the two periods are shown side by side:

	1905-9.	1911-16.
Gross amount of metal melted	4,833 tons	9,899 tons
Total consumption of fuel	2,677 tons	121 million cu. ft.
Consumption of fuel per ton melted	11 cwt.	12,220 cu. ft.
Cost of fuel per tons of metal melted	21.3s.	20.58s.

(3) *Cost of Graphite Goods.*—The crucibles used for both the coke-fired and the gas-fired furnaces were of the Morgan salamander brand, the mixture being modified in the latter case to suit the firing. A considerable extension of life was found when they were used with gaseous fuel.

The total inclusive costs for the two periods are placed side by side, and show that the rate per ton melted has been reduced by about one-third:

	1905-9. (Coke Fuel)	1911-16. (Gas Fuel)
Weight of metal melted	4,833 tons	9,899 tons
Total cost of crucibles, etc	£9,625	£13,295
Cost of crucibles per ton melted	39.8s.	26.8s.
Rate of reduction in costs		32.6 per cent.

The figures for costs shown cover in each case the purchase of muffles, covers, stands and stirrers as well as crucibles.

(4) *Cost of Labor.*—Coke fuel necessitates considerable handling; gaseous fuel is delivered at the furnace without manual labor. During 1905-9, the average annual consumption of coke was 535 tons. Two men were employed in each melting house to transfer the coke from the store to the furnaces as required and to remove the ashes and clinker. This labor, as well as that of periodically feeding the furnaces, was abolished with the introduction of gas fuel.

Ideals in Melting Metals

By Carl Hering

THE object of the paper is to summarize the principles underlying the best possible conditions for the melting of metals, chiefly from the standpoint of the thermal engineer, for the purpose of showing the directions in which to look for possible progress toward these ideals, and for pointing out the limitations imposed both by theory and practice, showing how they might be more closely approached in practice.

The possible directions of improvements are enumerated and discussed with the ultimate object of reducing the total cost of melting per pound of satisfactory castings. An intelligent combination of small economies may amount to an appreciable total. Economies should be properly compared; for instance, it is shown that the use of the more costly electric heat instead of cheap fuel heat may sometimes result in less total cost, notwithstanding an increased cost of the heat and of the plant.

The losses of heat are analyzed, and it is shown how some of them may be reduced. Heat insulation, over-insulation, reducing the time the metal is hot, the advantages of rapid heating and casting, superheating and how the thermal losses caused by it can be reduced, are discussed. The characteristic differences between combustion and electric heat and their effect on metal heating are pointed out. The causes of the loss of zinc during melting are briefly considered.

Gas as Fuel for Melting Alloys

By S B Brook

SOME years ago experiments were made in the University of Sheffield which went to show the material advantage possessed by gas over other fuels for the melting of non-ferrous alloys. The results were sufficiently promising to prompt the author to carry out a severe test and one of longer duration.

It was decided, therefore that such tests should be carried out on material which demands probably the highest temperature of any industrial non-ferrous alloy, namely, cupro-nickel; that the test should extend over not less than 10 full days of 10 hours each and commercial practice in the size of the ingot, etc., should be followed. It was the author's endeavor to provide melting data obtained from an experimental run on a sufficiently large scale to eliminate such misleading conclusions as are sometimes inseparable from the translation of laboratory experiments into works practice.

A gas-fired pit furnace of a modern type was placed at the author's disposal and it is the relative advantage of this fuel as compared with coke that forms the basis of the paper. The writer had hoped to embody data relative to an oil-fired pit furnace, but pressure of war work precluded this.

Summary of Tests

The following summary in form of question and answer sets out the objects of the test and the deductions to be drawn therefrom:

(1) Would ordinary coal gas give a temperature that was sufficiently high for this alloy?

(a) No difficulty at all was obtained in securing a temperature of 1,400 degrees Cent.

(2) What was the relation between the coke-fired furnace and the gas-

fired furnace from the following standpoints?

(a) *The Relative Cost of Melting.*—Average cost of melting with high grade metallurgical coke, 36/4 per ton; with gas at ordinary Sheffield rates, 31/9 per ton; and at the preferential rate allowed to users of gas for gas engines, 24/2 per ton.

(b) *Relative Speed of Melting.*—It was under this heading that the great advantage was shown by gas over coke. The same weight of metal can be melted in the gas furnace in 52 minutes which required 82 minutes in the coke-fired furnace. When this advantage is translated into commercial practice, the advantage is still more striking; for on two days during the test it was possible to obtain 12 heats in the 10-hour period, whereas the writer has only on very exceptional days been able to obtain seven heats from a coke-fired furnace per day.

(c and d) *The life of the crucibles and the wear and tear of lining and burner.*—The graphite crucibles of the same make have as long, if not a longer, life in properly controled gas-fired furnaces as in coke. The lining of the furnace and the burner suffered no depreciation of appreciable seriousness.

(e) *Metal Losses.*—Such loss was found to be below the average, and from the general stability ensured to the crucible mechanical loss ought to be far less than in the coke-fired type.

(f and g) *Labor and Capital Charges.*—The labor charges per ton of metal produced would be less in the gas-fired furnace from the fact that a larger number of furnaces can be controled by the same staff and the output of such a team of men would be higher in the case of gas-fired furnaces.

Quality of Product.—The cupro-nickel was tested at every stage and was found to be satisfactory. The ultimate test in the production of bullet sheaths, showed that the material was equal, if not superior in both quality and minimum failures, to any that had been produced in coke-fired furnaces.

The absence of ashes, the elimination of the wasteful process of slagging, the economy of fuel in ease of control, and the reduction of impurities introduced in the process of melting, are factors of considerable importance to the manufacturer and confirm the writer's findings that the claims of coal gas as a fuel for the melting of non-ferrous alloys rest on a very sound economic basis.

Melting in a Crude-Oil Furnace

By H S Primrose

IN MANY places where large outputs of brass are required it has not been possible to obtain sufficiently cheap gas or the necessary pressure. There the greatest use has been made of various forms of oil furnace, and the author describes a simple type which he has helped to evolve to do away with the difficulty of skilled labor.

The furnace may be so made as to take variously sized crucibles, and results are quoted of the working of these furnaces with 100 and 200-pound pots.

A full description of the construction and working of the furnaces is given, and recommendations are made as to the best method of regulating the amount of air required for the most complete combustion of the oil, supplied through either a high or a low pressure burner. The furnaces being placed on the floor level require no flues, and thus save trouble in cleaning.

Their first cost is not great and repairs are few and inexpensive. With the low pressure burner they are not so destructive on crucibles as the more cutting gas flame.

Some actual melting results of a battery of this type of furnace are quoted to show the amount of work they are capable of doing on a continuous run.

Electric Heating of Crucibles

By H C Greenwood and R S Hutton

THE authors have had occasion to note the great improvement in working qualities of nickel-silver alloys melted with gas over similar alloys melted with coke. Electric heating should show an even greater advantage. For non-ferrous alloys a construction of furnace suitable for using ordinary crucibles is especially desirable.

The electric furnace designed by the authors takes a 100-pound plumbago pot. The electric heating is independent of the crucible, the furnace being of the resistance type, the current passing through upright carbon rods situated near the inner face of the walls of the furnace; the heating thus is under perfect control.

Actual tests carried out with a charge of 90 pounds of nickel-silver took three hours for the first heat and one hour 35 minutes for the second heat; the energy consumption was 53.6 and 29.2 kilowatt hours respectively.

The principal advantages to be expected from electric heating are (1) absence of gas currents, reducing spelter losses and making the maintenance of a reducing atmosphere relatively simple; (2) lower sulphur contamination; (3) greatly enhanced life of crucibles; (4) improved quality of metal.

The further development of this furnace was postponed, owing to the difficulty of obtaining carbons in England at the commencement of the war. A description of the work in its complete form is, however, given with the object of encouraging others to devote their attention to the development of a commercially practical electric furnace.

What is Beryllium?

In the April issue of *Mineral Foote-Notes,* published by the Foote Mineral Co., Philadelphia, Prof. C. James, of the New Hampshire College, Durham, N. H., discusses beryllium, which he states is an element, the occurrence of which in the combined state is by no means so uncommon as one is generally led to believe. It is also a substance about which much has been predicted and little accomplished.

The facts that there are only a few industrial uses for the compounds and at present practically no uses for the metal, seem to be due to two causes. First, that so few realize the future possibilities of the mineral sources. The mineral which is both best known and commonest is beryl. It occurs in several localities in the eastern states and is widely distributed throughout the world. In many places it occurs massive and may be easily mined. It is true that many deposits are off the beaten track, but these would readily become accessible as soon as the demand became great enough.

The second cause is due to the difficulty in preparing the pure compounds, for beryl itself is somewhat refractory, and the separation from aluminum none too easy. The separation of beryllium from aluminum deserves a careful and systematic study on a large scale. The literature on beryllium indicates several possibilities, especially along lines of fractional precipitation. A very little research will soon show that the manufacture of beryllium salts upon a large scale will cause the price to fall far below that existing at the present time.

Many of the beryllium minerals are of interest, since, when perfect and of good color, they are used

in jewelry. The emerald, which is a fine green variety of beryl, occurs in the world-famed Muzo mine near Bogota in Colombia and at Coscuez and Somondoco. It is also found in Russia, New South Wales, etc.

Chemical Extraction

For the extraction of beryllium salts, the common large opaque beryls are used, of which single crystals are sometimes found weighing more than a ton. This material contains on the average a little more than 12 per cent of the oxide.

One of the simplest methods for the working up of beryl consists in fusing the finely powdered mineral with an equal weight of sodium hydroxide. The resulting product is treated with sulphuric acid to convert the beryllium and aluminum to sulphates, after which the mass is heated to render the silica insoluble. Upon boiling out with water, the beryllium and aluminum are found in solution along with sulphate of sodium.

It is usual to separate the beryllium from aluminum by taking advantage of the fact that the former is soluble in ammonium carbonate or sodium bicarbonate solutions, while the latter is insoluble.

In carrying out research upon the separation of beryllium from aluminum, it is always well to remember that beryllium will give many reactions differing from aluminum, yet when the two are mixed together this line of demarcation is found to exist no longer. Perhaps it would always be advisable to follow up such reactions; for might it not be possible to find the conditions under which each substance followed its normal behavior?

Beryllium hydroxide exists in several forms, one of which resembles aluminum hydroxide in its properties, while another is said to resemble magnesium hydroxide. It is therefore evident, if these two forms occur, that the best condition for the separation will be to have the beryllium hydroxide present in the form where it resembles magnesium, because in this state the two substances present the greatest differences.

The writer is of the opinion that either fractional solution or fractional precipitation will be finally found to give a very cheap method for the production of compounds of the element under discussion.

Metallic Beryllium

The metal itself is still little known. The chloride is easily reduced by sodium, yielding the metal in the form of silvery globules. Unfortunately the anhydrous chloride which must be used for this purpose is very troublesome to make and it becomes necessary to find a process more easily followed.

Metallic beryllium is said to be obtained by the alumino-thermal reaction. The beryllium oxide is reduced by aluminum by heating the mixture until the reaction commences and then rapidly applying external heat, so that a temperature above the melting point of the metal is reached. This process, which has been quoted as giving a metal of 90 per cent purity, is patented in Germany.

The ideal method, toward which all look forward, will be parallel to that used for the extraction of aluminum. It is highly probable that a great deal of work will have to be performed before this is achieved, and it is to be expected that the process will not run quite as smoothly as in the similar case.

Beryllium Compounds

Since the element appears to be malleable, light and silvery in appearance, and since it is permanent in air and apparently not affected by water, it would seem to possess some very good properties. Several alloys have been prepared. Those with copper resemble the corresponding ones of aluminum and copper. One and one-half per cent of beryllium makes the copper assume a yellow color, while 5 per cent makes a golden yellow alloy.

Beryllium oxide is perhaps the most important compound as yet, for it has several industrial applications. It is used in the manufacture of incandescent mantles in order to make them stronger. The amount used depends upon the manufacturer. Some makers use 5 grams of beryllium nitrate to every kilogram of thorium nitrate, while others use only 2 grams to the same quantity of thorium salt. The addition of the beryllium salt is very useful in the manufacture of mantles possessing some definite form.

The oxide is sometimes added to material that is being used for the manufacture of abrasives.

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Porous Copper Castings

We are making a mixture consisting of copper, 88 per cent; tin, 6 per cent; lead, 3 per cent, and zinc, 3 per cent, but the castings invariably are porous. We are wondering if by changing the mixture to 85 per cent copper, 6 per cent tin, 6 per cent lead and 6 per cent zinc, using phosphor-copper as a flux, better results could be obtained. What is the most suitable flux for preventing oxidation in an oil-fired furnace of the pit type?

The mixture comes porous because the metal is allowed to absorb oxygen and other gases while it is being melted. Changing the mixture will not overcome the difficulty. The use of phosphor-copper is advisable, although it must not be presumed that its use will obviate porosity unless precautions are taken while melting. For an oil-fired furnace the most suitable flux is one of a sticky nature, as the force of the flame sweeps away the charcoal. Green bottle glass makes a good flux. Use the glass in conjunction with powdered anthracite coal and a little salt. Have the surface of the metal entirely covered.

If the proper precautions are used in melting the mixture, and if the flux is made up of the materials mentioned above, the porousness which you have experienced should disappear.

Melting Copper in Cupola

We have an order for three bronze castings weighing approximately 3,000 pounds each, to be made of the following composition: Copper, 82 per cent; lead, 10 per cent; tin, 4 per cent, and zinc, 4 per cent. Our brass furnace has a capacity of only from 800 to 1,000 pounds, but we have three iron cupolas which could be used in making the melt. I would like to know the best way to make these castings, either in the cupola or in some form of brass furnace which we could construct here.

Mix the proportions of lead, tin and zinc in crucibles in a separate furnace and melt nothing but copper

in your iron cupola, being quite sure the latter is thoroughly cleaned beforehand.

Melt preferably with a low sulphur anthracite coal. You can, however, use one-half coke and one-half anthracite, in which case you will have additional sulphur trouble to contend with.

Melt as in ordinary gray iron practice, being very careful not to blow too long, using 8 to 10-ounce blast pressure, and stop blowing as soon as the copper is melted. Tap out into a large ladle and add the crucible mix while the ladle is in process of filling. Slant your cupola bottom well toward the tapping hole to permit of all metal running out. You will, of course, understand about charging enough metal to make up for any losses.

After tapping the iron cupola, we advise the use of lump charcoal on the top of the metal to prevent oxidation due to atmospheric conditions. Oxidation does not necessarily occur during the process of melting the copper, but after the metal has become fluid, then oxidation will occur very rapidly. Do not overheat or use the blast any longer than necessary to melt the copper.

The melting points of the tin, zinc and lead are so low compared to the copper, that they readily dissolve in the molten copper, thereby eliminating one of the greatest dangers in crucible melting, chiefly caused by the oxidation of zinc and tin.

All that is necessary by this method would be to bring the tin, zinc and lead up to a fluid point, in order not to chill the copper too much and to bring about a more uniform mixture in the large ladle. Care should be exercised in melting the copper to use a low sulphur fuel.

White Aluminum Alloy

We would like to have the mixture of an aluminum alloy which will have a white appearance when polished.

The following alloy will be found to be as white as it is possible to make alloys of aluminum: Aluminum, 81 per cent; copper, 2 per cent; tin, 2 per cent, and zinc, 15 per cent.

Flux for Brass Particles

On page 157 of the April issue of *The Foundry* was published the analysis of a mixture under the caption of "Flux for Small Brass Particles". The component parts of this flux were given as follows: Lime, 10 per cent; powdered fluorspar, 30 per cent; salt, 10 per cent, and soda ash, 20 per cent. In place of per cent the components should have been given in parts.

White Metal for Art Work

We would like to cast small statuettes and busts in zinc or a white metal mixture and we would like to have you furnish us with the components of such an alloy. Also, we would like to have a fairly hard, sharp casting, silver-like alloy, suitable for making pendants for watch fobs.

The following alloy will be satisfactory for statuettes: Lead, 80 per cent, antimony, 10 per cent, and tin, 10 per cent.

For pendants for watch fobs use tin, 89 per cent; antimony, 8 per cent, and copper, 3 per cent.

In making the latter alloy, melt the copper separately in a graphite crucible, add the antimony and about 15 per cent of the tin. Melt the remainder of the tin separately and pour the copper-antimony-tin alloy into the molten tin, stirring it thoroughly in the meantime.

Lining for Melting Furnace

Can a satisfactory lining for an oil brass melting furnace be made from ordinary fire clay and sand? If so, kindly let me know what proportions of each to use. I would like to place a wood core in the center of the shell and ram in the clay the same as in a mold. Should it be very soft for this or only slightly moist?

Whether a satisfactory lining can be made from the materials named will depend upon their quality. If the sand is white silica and the fire clay low in alkalies and iron oxide, they will make an excellent lining if mixed in the proportion of 32 per cent clay and 68 per cent sand. This will give a mixture containing around 80 per cent silica and from 7 to 8 per cent alumina, corresponding to the composition of a good ganister. The mixture should be dampened with water like wet molding sand and should be well rammed into place.

Magnalium Castings

I have been endeavoring to make some small castings of magnalium for surgical instruments. Can you tell me how this metal is mixed; that is, should the aluminum be melted first and the magnesium added, or should both be melted at the same time? I have had trouble with an experimental heat. The entire mass was badly burned.

In making aluminum alloys always reserve a small portion of the charge for cooling purposes, as it is very easy to heat aluminum to a cherry red in an ordinary brass melting furnace. This temperature is harmful to the aluminum. In making magnalium, heat the aluminum to a just visible redness and add the magnesium. The latter metal melts at 633 degrees Cent., and the aluminum will be at a temperature between 700 and 800 degrees Cent. Therefore, the magnesium will readily melt and alloy. If the aluminum accidentally gets to a full red, use the reserve metal for cooling. The pouring temperature will depend upon the thinness of the castings. Very thin castings will have to be poured at 800 to 850 degrees Cent. in order to run them. Heavy castings poured at this temperature will be worthless. Therefore, pour as cool as possible consistent with running the work. Use a tough molding sand that can be worked quite dry and will hang when soft rammed.

Mixture to Hold Gasoline

We would like to have a mixture for valve stems and cages for gasoline pumps and we find that a metal that will withstand steam and water pressure will not hold gasoline. At present we are using 80 per cent copper, 8 per cent tin, 7 per cent lead and 5 per cent zinc, with the addition of a small amount of phosphor-copper, approximately ¼ pound to 100 pounds of metal. This alloy has a tendency to tear when grinding the seat. We would like to have a mixture that will machine easily and which can be ground satisfactorily.

We suggest a trial of the following mixture: Copper, 78 per cent; tin, 7 per cent, and lead, 15 per cent, using for a deoxidizer about the same amount of phosphor-copper as in the alloy given.

Facings for Brass Castings

Kindly let us know whether plumbago can be used satisfactorily as a facing for molds for brass castings. What is the best mixture to use for brass bolts?

Plumbago frequently is used as a coating on molds for producing brass and bronze castings, particularly when the latter are massive, but it is not required for some castings. It usually is applied dry with a camel's hair brush and afterwards may be slicked or polished by the fingers or with molding tools. The plumbago is painted on large dry sand molds in the form of a wash of the consistency of cream. The wash usually is made by mixing plumbago with weak molasses water. For some small brass castings, flour usually is dusted over the molds and this is blown off by the bellows or air jet.

A good mixture for brass bolts follows: Copper, 89.5 per cent; tin, 6 per cent; zinc, 3 per cent, and lead, 1.5 per cent.

If a very strong alloy is desired, the following is recommended: Copper, 59 per cent; zinc, 40 per cent; tin, 0.5 per cent, and aluminum, 0.5 per cent.

A Study of Inclusions of Alumina in Steel

With Our Present Knowledge We Cannot Be Sure That Alumina Particles Will Not Segregate in Castings or Ingots

By George F Comstock

THE subject of non-metallic inclusions in steel is one that has attracted remarkably little attention among students of metallography considering the vast amount of work that has been done in recent years in the investigation of metallic structures with the microscope. Indeed the tendency is still far too common among metallographists to give the general name slag to all substances seen in polished steel surfaces that are not metal. This is especially unfortunate in regard to sulphides, which obviously are not slag, and it should be equally desirable to distinguish between other typical inclusions, such as silicates of iron or manganese, iron oxide or scale, alumina, and titanium nitride. The objects of this paper are to call attention to the fact that alumina can be distinguished from other non-metallic inclusions in steel, to indicate how it can be recognized, and to show a few examples of the harm arising from it when locally abundant.

In the literature dealing with inclusions in steel there are but few references to alumina. One of the earliest of these, and also the most definite, is in an article by Heyn and Bauer, entitled "Kupfer, Zinn, und Sauerstoff", published in the *Zeitschrift fur Anorganische Chemie*, 1905, No. 45, page 63. This reference to alumina, freely translated from the German, is as follows:

"The film-like enclosures of tin oxide in bronzes bear much similarity to the enclosures in mild steel which has been deoxidized with aluminum instead of manganese. A photomicrograph, Fig. 1, shows such enclosures which consist, as found by analysis, of alumina. Also, in copper-magnesium alloys similar enclosures can be observed which are due to thin films of magnesium oxide."

FIG. 1—ALUMINA IN STEEL DISCOVERED BY HEYN AND BAUER

Fig. 1 is a transparency copy, made by the United States bureau of standards of the photomicrograph published by Heyn and Bauer to show the alumnia inclusions, magnified 29 diameters. This same photomicrograph was used by Martens and Heyn in "Materialenkunde fur den Maschinenbau", No. 2A, page 207, from which the following is quoted and translated freely:

"A similar case (of non-metallic inclusions) can also be found in mild steel to which aluminum has been added before the deoxidation is complete. The alumina arising from the combination with oxygen is held in the metal on account of its infusibility and forms foam-like films which are visible after solidification, as shown in Fig. 1 (referring to the same photomicrograph, magnified 29 diameters, first published by Heyn and Bauer). The dark lines and specks are Al_2O_3. A steel which after solidification contains such foam-like films is not workable, but will crumble when forging at a red heat is attempted. A piece of such steel was found to be extraordinarily red-short, and when rolling was attempted it split and formed collars on both the upper and lower rolls."

Referring to the use of aluminum as a deoxidizer, and the resulting formation of alumina, Dr. Walter Rosenhain, in his "Introduction to the Study of Physical Metallurgy", page 153, writes as follows:

"A more powerful deoxidizing agent than manganese is furnished by aluminum, but this differs from manganese in two vitally important respects. In the first place, the oxidation product of aluminum is a particularly refractory substance, alumina, which has a strong tendency to remain in the molten metal in suspension as fine particles. These, of course, tend to lessen the strength and toughness of the alloy."

A paper read at the annual meeting of the American Foundrymen's Association, Cleveland, Sept. 11 to 15, 1916.

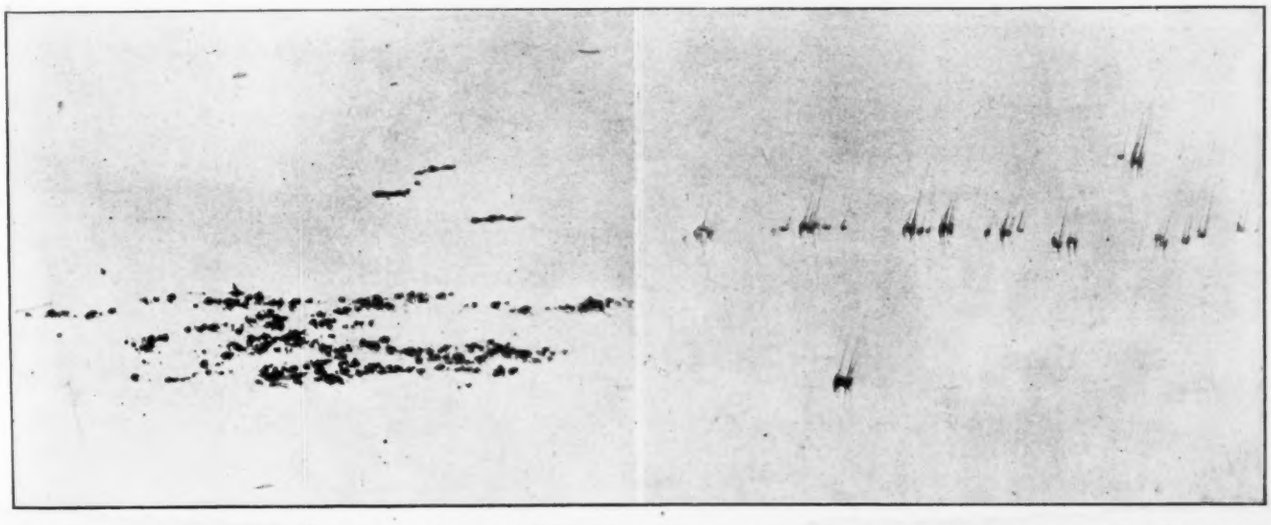


FIG. 2—ALUMINA INCLUSIONS IN A BAR OF AMERICAN STEEL

FIG. 3—ALUMINA PITS APPEARING IN THE FORM OF SHORT SCRATCHES

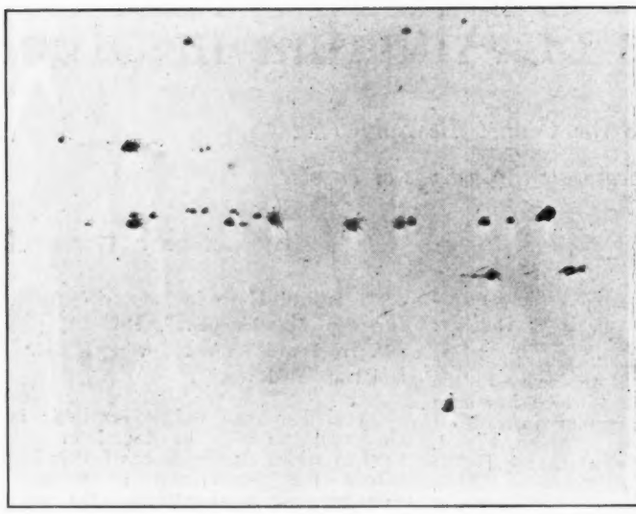


FIG. 4—SAME STREAK OF ALUMINA PARTICLES AS SHOWN IN FIG. 3 AFTER GRINDING AND MORE CAREFUL POLISHING

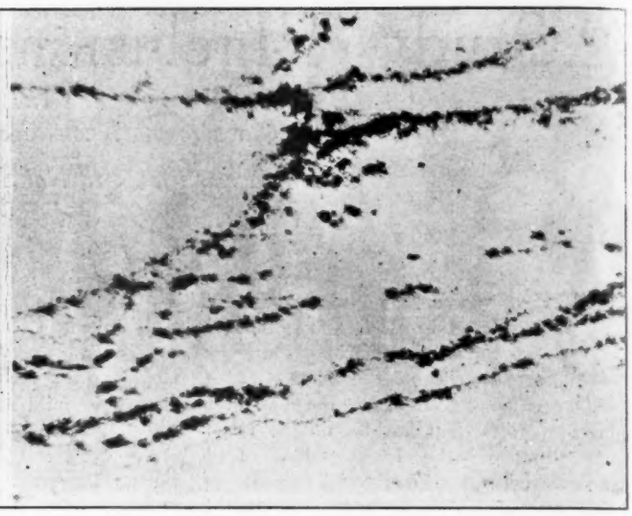


FIG. 5—BAR OF STEEL SHOWING CHARACTERISTIC DISTRIBUTION OF INCLUSIONS OF ALUMINA PARTICLES

In a paper entitled "The Solid Non-Metallic Impurities in Steel", published in the *Transactions* of the American Institute of Mining Engineers, Vol. XLI, pages 803-822, Henry D. Hibbard writes, in part, as follows:

"If other elements have been added, such as aluminum, chromium, or vanadium, their oxides and silicates may be present. * * * The too plentiful use of aluminum in steel may have been condemned, partly at least, because it forms oxides or silicates in the metal, which, being insoluble, and infusible, exist in the solid steel as very harmful sonims. Of course, to form the oxide there must still be some oxide of iron or manganese in the steel. If the metal were free from oxygen perhaps the weakening effect of aluminum * * * would not occur."

The various writers quoted above unmistakably recognize the existence of alumina as a frequent non-metallic impurity in steel. They are aware of the potential harmfulness of this impurity, but they do not give any idea as to how it may be recognized and identified in metallographic work. To supply this deficiency was the object of the author's article on "Alumina in Steel", published in *Metallurgical and Chemical Engineering*, Dec. 1, 1915. This article described the experiments made to ascertain the characteristic appearance of alumina in steel, and showed numerous photomicrographs to illustrate it. The work will not be gone over in detail here, as the original article can easily be referred to, but some of the typical photomicrographs are shown again with descriptions of alumina inclusions and the points wherein they differ from sulphides, slag, etc.

Fig. 2 shows the inclusions in the first bar of steel that came to the author's attention, in which alumina was known to be present. The inclusions are in the form of small rounded spots, arranged close together in one elongated streak. They are of a very dark bluish-gray color, when examined with the white light of an electric arc, appearing black unless highly magnified. It was almost impossible to polish them without forming little pits around each inclusion. If the polishing is done very carefully, these pits may be kept very small; but with certain methods of polishing the pits are made so large that the original inclusions cannot be seen at all. If the specimen is not rotated continuously during the final polishing, the pits take the form of short scratches, and each inclusion will have a little tail like a comet. This is illustrated in Fig. 3, while Fig. 4 shows the same streak of alumina particles after grinding and more careful polishing.

Fig. 5 shows another bar of steel, like Fig. 2, in which the occurrence of alumina was assured, and the general similarity of form in these two instances is apparent. Although these both show longitudinal sections of forged bars, the individual inclusions

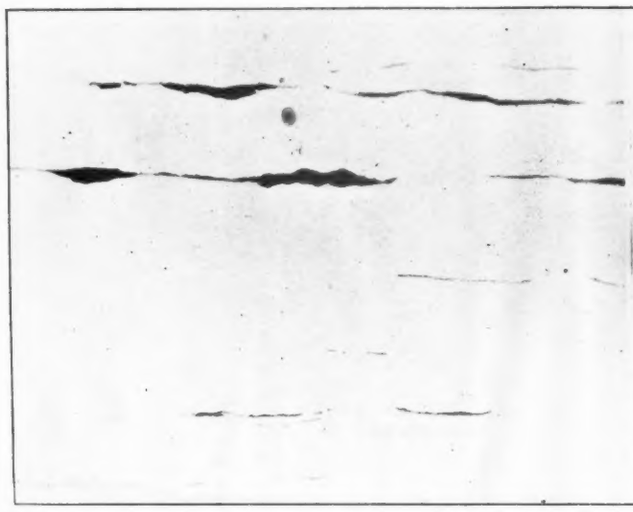


FIG. 6—TYPICAL SILICATE INCLUSION IN ROLLED STEEL BAR

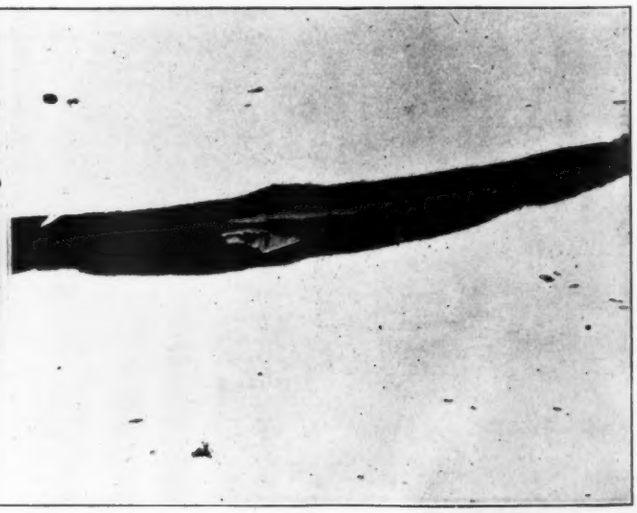


FIG. 7—ANOTHER EXAMPLE OF SILICATE INCLUSIONS IN STEEL

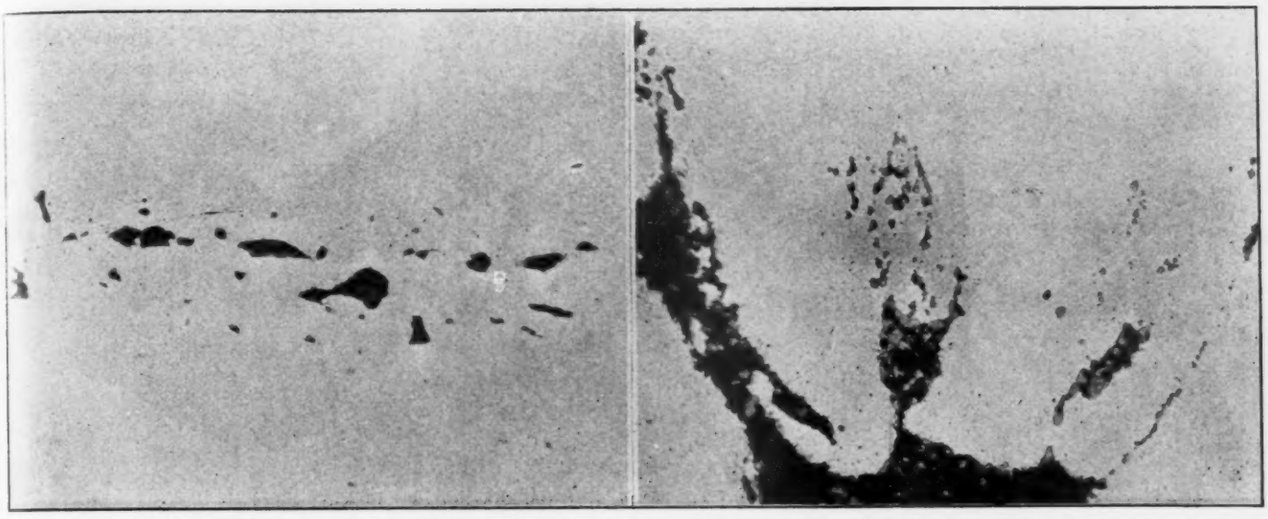


FIG. 8—COMPLEX SLAG INCLUSIONS IN STEEL

FIG. 9—CHROMIUM OXIDE EMBEDDED IN STEEL

have not been elongated by the forging, but merely the groups of particles have been drawn out into streaks. Compare these with Figs. 6 and 7, showing silicates in rolled bars, and a great difference is evident at once, for the individual silicate particles are very much elongated in the direction of rolling. It should perhaps be noted here that there is no difference between rolling and forging in their effects on particles of either alumina or silicates.

The differences between inclusions of alumina and ordinary slag or silicates in steel were summarized as follows: (1) Silicate inclusions will generally take a fairly smooth polish in a section prepared for microscopic examination, while alumina is very hard to polish without pitting. (2) Silicate inclusions are always elongated in the direction of rolling or forging, while alumina particles are not. The groups of particles are of course elongated, but not the particles themselves. (3) Silicate inclusions are often found of quite large size, as well as very small, while particles of alumina are always small, and do not seem to coalesce into large bodies even when closely grouped together. These characteristics of alumina inclusions agree with what is known of the properties of alumina. Its great hardness and brittleness would account for the pitting effect; its infusibility would account for the small size of the particles and the tendency not to coalesce; and both of these properties together would account for the particles not being elongated by forging or rolling of the steel in which they are embedded.

Appearance of Alumina

My former article, pointed out that no other substance was known that had exactly the same appearance as alumina in a polished steel section, and this statement still holds true. Fig. 8 shows some complex slag inclusions, probably containing titanium, since the steel was treated with oxide of titanium before casting. Evidently it cannot be said that this oxide looks like alumina. Fig. 9 shows oxide of chromium embedded in steel. These resemble alumina slightly in a photograph, but when seen directly through the microscope they may be distinguished by their smooth polish and purplish color. Fig. 10 shows the inclusions in steel treated with nickel oxide. These are probably oxide of iron, and could not be mistaken for aluminum. Titanium nitride crystals are easily identified by their angular form and pink or orange color, which is shared by no other substance in steel. The differences between silicates and alumina have been pointed out above, and sulphides are of course known to nearly all metallographists by their smooth dove-gray appearance. Thus the appearance of alumina is believed to be distinct, and warrants the identification of this substance in steel by metallographic examination.

The author's work in establishing this identification was based largely in checking the microscopic evidence by chemical analyses. It was stated in the previous

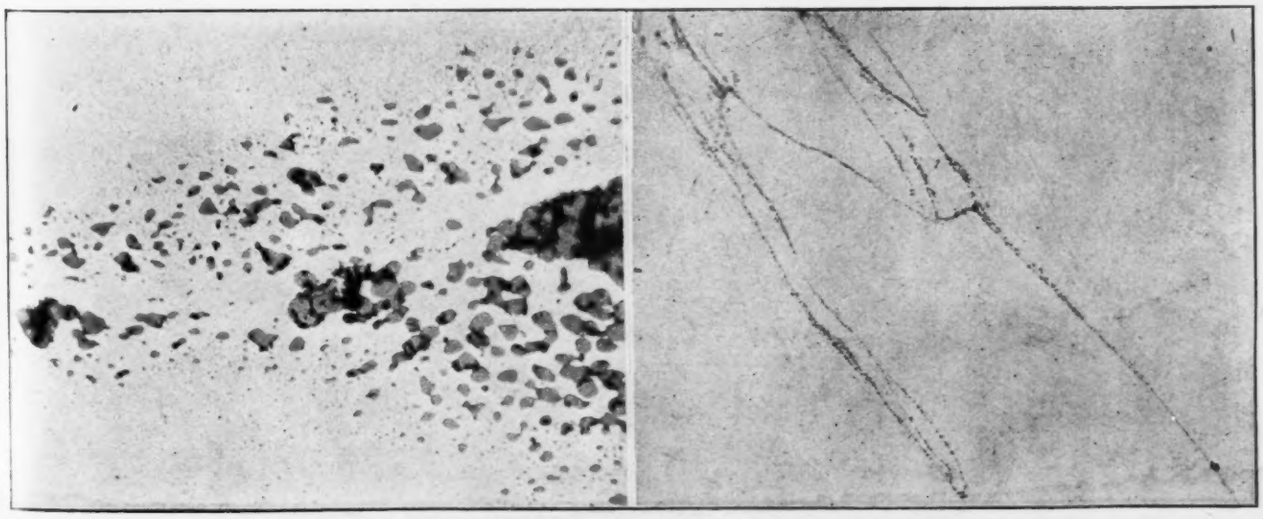


FIG. 10—INCLUSIONS IN STEEL TREATED WITH NICKEL OXIDE

FIG. 11—ALUMINA PARTICLES IN SAME SAMPLE AS SHOWN IN FIG. 5 BUT MAGNIFIED LESS (Sauveur)

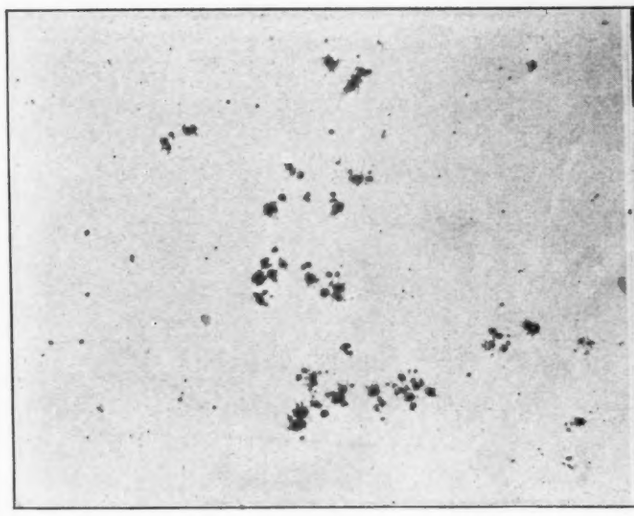


FIG. 12—ALUMINA INCLUSIONS IN A SOFT STEEL CASTING

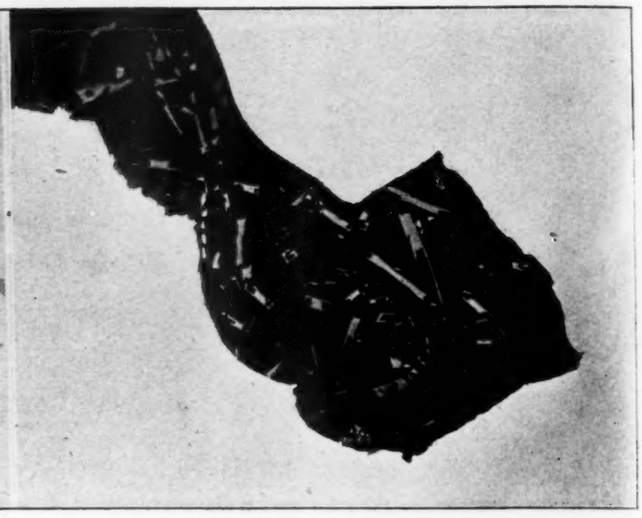


FIG. 13—LARGE, TYPICAL SLAG INCLUSION IN STEEL CASTING

article that all samples in which more than the merest trace of alumina was found by analysis were seen to contain the typical inclusions as described above, and those in which alumina was not found by analysis, did not contain these inclusions. Furthermore, those in which more alumina was found by analysis contained more of these inclusions than those in which only a very little was found. It might perhaps be well to mention the fact that these analyses were not made under the author's direction, but in a different laboratory, and neither the chemist nor the metallographist knew each other's results until the work of both on any given sample was completed. The methods in the chemical determination of alumina in steel are described in the booklet "Ferro Carbon-Titanium in Steel Making", Titanium Alloy Mfg. Co., pages 99 to 105, and in the course of his remarks on the chemical side of the work, the writer, L. E. Barton, states that "the results show conclusively that alumina may occur in the free state in steel, and greatly strengthen the probability that free alumina may be detected by metallographic examinations."

The well known metallographist, Prof. Albert Sauveur, of Harvard University, has recently completed an independent investigation dealing with the occurrence of alumina inclusions in steel, in the course of which he examined some of the author's specimens as well as some that he himself prepared. His report of this work was published in the Aug. 1, 1916, issue of *Metallurgical and Chemical Engineering* and in the *Iron Age* and *Iron Trade Review* for July 27, 1916. Fig. 11, on page 199, is a photomicrograph taken by Prof. Sauveur of the same sample shown in Fig. 5, but magnified only about 36 diameters. It illustrates well the "filmy" arrangement sometimes assumed by alumina particles, as mentioned by Martens and Heyn, quoted above, and represented by Heyn and Bauer in Fig. 1. A comparison of Figs. 11 and 5 indicates that the "dark lines" said to be Al_2O_3 in Fig. 1, which is magnified only 29 diameters, were in all probability made up of fine rounded particles like those described by the author and shown in Figs. 2 and 5. The conclusion reached by Prof. Sauveur was that "alumina inclusions may be distinguished under the microscope from the other inclusions generally occurring in steel, being characterized by their small size, their dark coloration, and more especially by a complete absence of elongation in the direction of the rolling or forging."

It may seem that the characteristic appearance of alumina inclusions, as compared with slag or silicates, is only exhibited in worked steel, but this is not the case. The identification of alumina in cast steel calls for more care and experience than in worked steel, for small silicates here exist as globules instead of fibers, and might perhaps be mistaken for alumina if carelessly polished and examined. But the very dark color of alumina, its

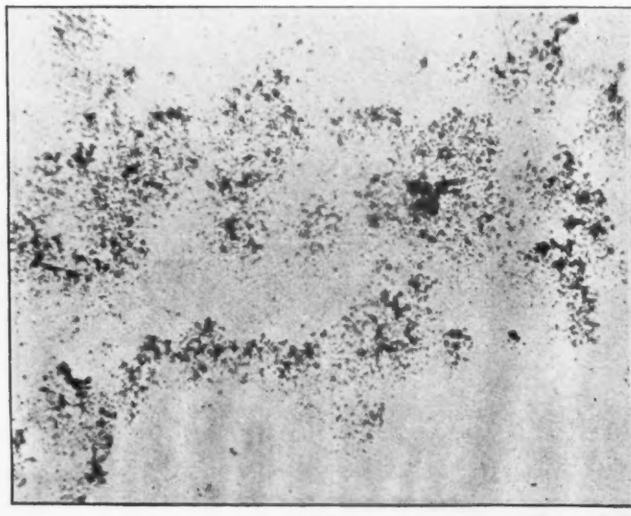


FIG. 14—SECTION NEAR TOP OF AN INGOT WHERE ALUMINA CONTENT WAS UNUSUALLY HIGH

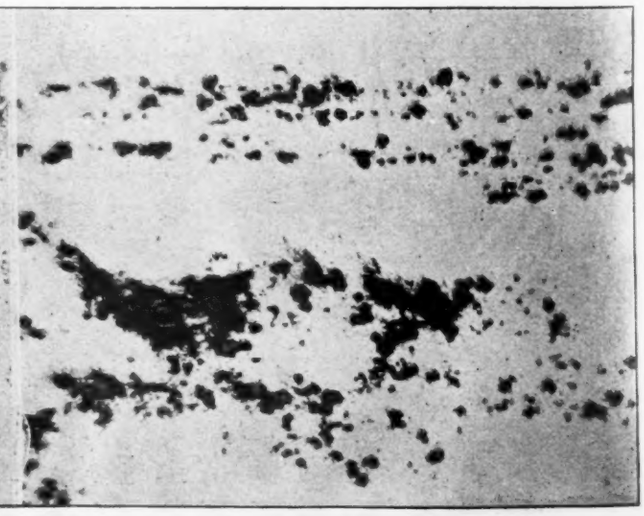


FIG. 15—WEAK STREAKS IN A STRUCTURAL STEEL BLOOM

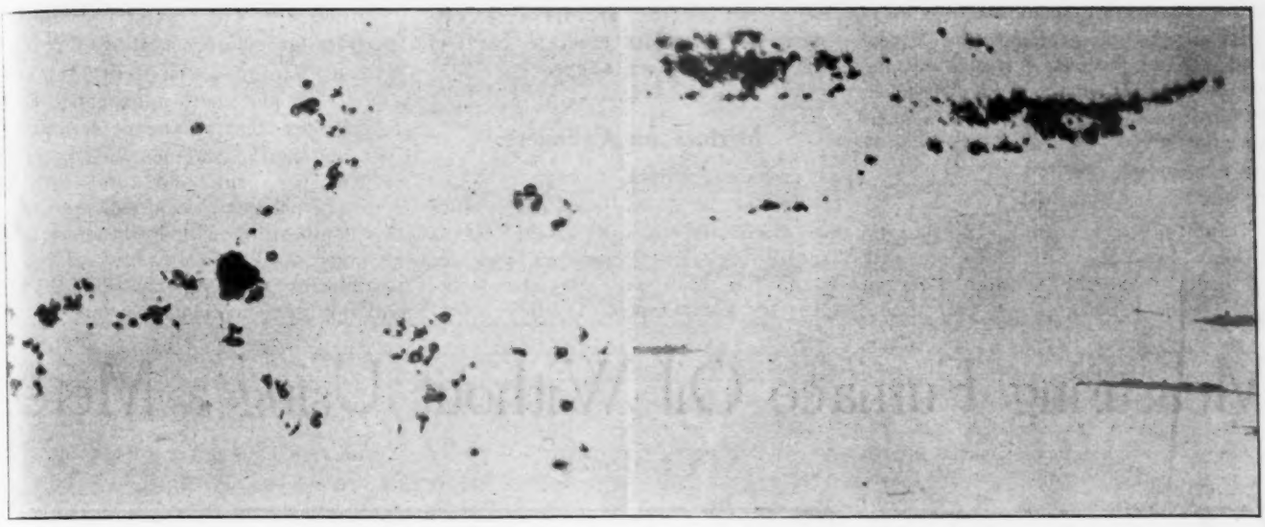


FIG. 16—ALUMINA PARTICLES NEAR FRACTURE IN LOCOMOTIVE TIRE

FIG. 17—ALUMINA AND SULPHIDE PARTICLES IN A FAILED RAIL

rough appearance and the pitting effect, and the invariably small size of the individual particles are sufficiently distinctive characteristics to enable it to be recognized in castings as well as forgings, especially if the observer is careful and already familiar with its appearance. Fig. 12 shows these inclusions in a casting of soft steel, where the presence of free alumina was established by chemical analysis of the insoluble residue from a large sample. Fig. 13 shows a fairly typical though large slag inclusion in another casting, and the sharp outlines of the slag, as compared with the rough appearance of the alumina, are clearly brought out. This slag, moreover, as is often the case, is evidently not homogeneous, but of duplex composition. Fig. 14 shows a section near the extreme top of an ingot, where the alumina content was excessively high. This foamy appearance is rare, but to a certain extent it resembles Fig. 1, as described by Martens and Heyn. The usual aspect of alumina in cast steel is the same as in forged or rolled steel, with the single exception that when the particles are grouped closely together in certain spots, these groups are of irregular or rounded shape in castings, instead of being elongated into streaks as in a rolled bar.

A similar difficulty to that experienced in castings may be encountered in cold-worked steel, such as wires, tensile test bars after pulling, etc. Here the slag or silicate fibers are usually broken up into fragments and drawn out into streaks, but if carefully polished the fragments of silicates can be recognized by their definite and angular outlines and their smooth surface, while alumina particles will be rougher, probably more or less pitted, and less distinctly outlined.

It is not desired to give the impression by this paper that alumina always exists in steel in the form of such large groups of particles as those shown in the photomicrographs. Its most usual mode of occurrence is probably in isolated particles, thinly scattered through the metal, and in this form it is practically harmless. The danger in its use as a deoxidizer lies in the fact that with our present knowledge, or under present mill conditions, we can never be sure that the alumina particles will not segregate or gather together in certain parts of the casting or ingot. When this happens the results are dangerously weak streaks such as is shown in part in Fig. 15, taken from a bloom intended for structural steel. Such streaks may not be common, but they nevertheless do occur when aluminum is used, and may cause great harm. A few examples will be mentioned in closing where failures in service could be directly traced to the presence of alumina.

Fig. 16 shows a group of alumina particles near the starting point of the fracture of a large driving tire on a railroad locomotive. No other defect could be found to explain the failure, except the presence of too much alumina, segregated in spots through the metal. Fig. 17 shows part of a streak of alumina and sulphide particles that caused the top of the head of a rail to break and shell off in the track. The contrast in appearance between alumina and sulphides is well brought out in this photomicrograph. Fig. 18 shows a section of a thin steel plate, on which blisters appeared after hot-rolling. A large streak of alumina was found near the surface of the plate, and part of this streak is shown in the photomicrograph. The black strip along one edge is space beyond the edge of the section, or beyond the surface of the plate, and the other long black spots are sections of blisters, the bright areas being, as in all the other photomicrographs, the polished surface of the steel. The metal evidently tore through the alumina streak, as the blisters are seen to lie in it, and the contraction of the hot interior of the plate after rolling caused the cooler outside layer to bulge outward, forming blisters where the separation or tearing in the alumina had taken place.

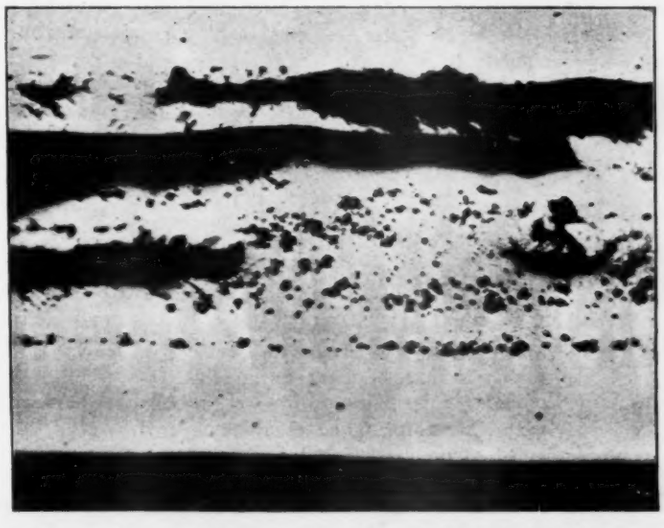


FIG. 18—SECTION OF A BLISTERED THIN STEEL PLATE

Before closing, it should be mentioned that all the photomicrographs, except Fig. 1, copied from a tracing by the bureau of standards, and Fig. 11, taken by Prof. Sauveur, were made at a magnification of 200 diameters, and no etching reagent was used.

Hamilton & Hansell, 17 Battery place, New York City, have received an order from the Chicago Bearing Metal Co., Chicago, for two 1-ton Rennerfelt electric arc furnaces, rated at 300 kilowatts each, to be used for melting copper alloys.

Mixture for Cylinders

By W. J. Keep

Question: — In the very near future we intend to engage in the manufacture of cylinder castings and we would like to know what iron mixture is best adapted to this work.

Answer: — The accepted standard analysis for cylinder castings follows: Silicon, 1.75 to 2 per cent; sulphur under 0.08 per cent; phosphorus, 0.40 to 0.50 per cent; manganese, 0.60 to 0.80 per cent; combined carbon, 0.55 to 0.65 per cent, and total carbon 3 to 3.25 per cent. You can approach this composition with irons obtainable in your market. However, if your phosphorus runs up considerably, it will do no appreciable harm.

Measuring Furnace Oil Without Using a Meter

By E Tonkin

A NOVEL method of measuring oil in a pressure tank without using a meter has proved satisfactory in securing data for comparing the cost of oil and natural gas fuel per ton of metal melted in a brass furnace. An oil tank, approximately 22 x 40 inches, was fitted up in the pipe shop with oil and air connections as shown in Fig. 1. The oil inlet was tapped into the center of the top head of the drum. By means of a *T* between the oil inlet valve and the drum, connection was made to an inlet air pipe and pressure gage. The oil line to the furnace was tapped into the lower head of the drum while an air outlet was fitted to the tank at a point on the side near the top head. Water glass valves were screwed into holes at two points in the side of the reservoir and were connected by a glass tube. A yard stick fastened in a parallel position alongside the glass served as a means of gaging the height of oil.

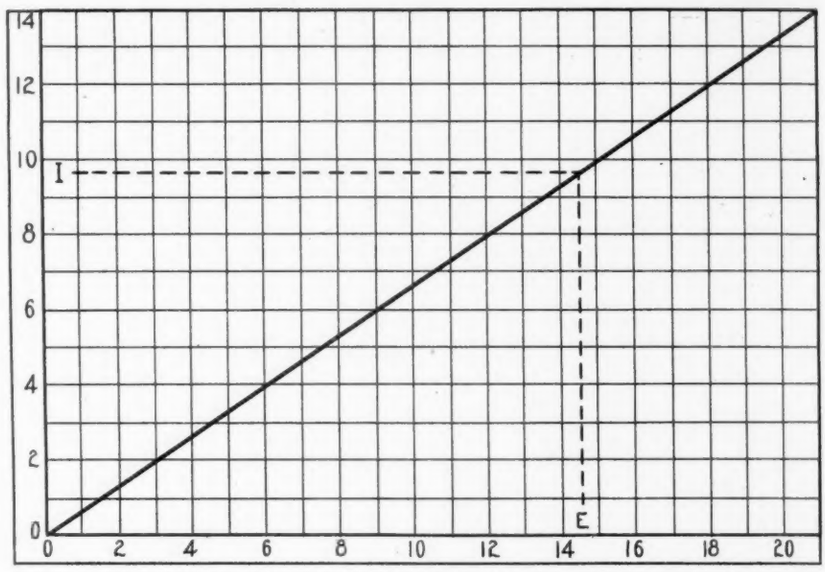


FIG. 2—PLOT SHOWING CORRESPONDING VOLUME FOR EVERY HEIGHT OF OIL IN THE RESERVOIR

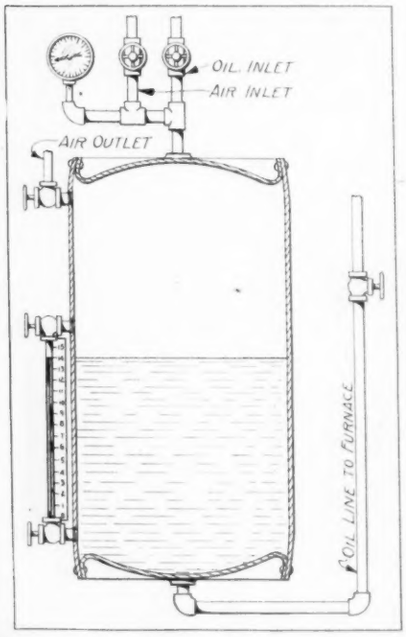


FIG. 1—ARRANGEMENT OF OIL RESERVOIR SHOWING METHOD OF CALIBRATION

The tank was calibrated by placing it on platform scales and weighing it, first when empty, and then with water at the level of each mark on the yard stick.

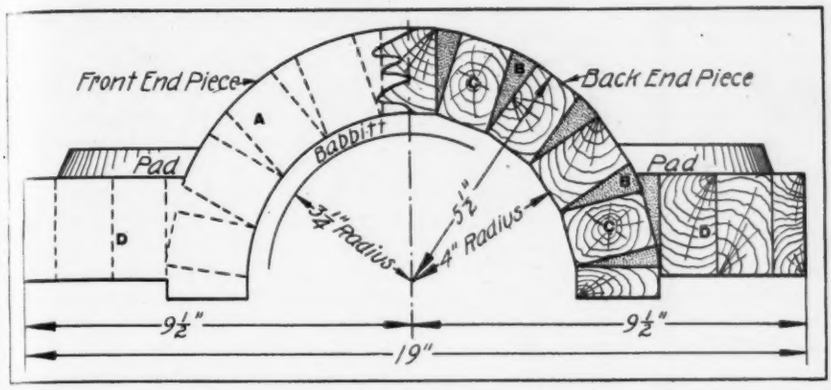
From these data was determined that 1 inch of water on the scale corresponds to a volume of 1½ gallons of water in the tank, therefore, the constant 1.5, may be used to convert the scale reading to a measure of the contents of the tank. The curve plotted in Fig. 2 was constructed on this basis.

The tank may be filled by reducing the pressure of air in the tank by opening the air outlet valve until the pressure is less than that of the incoming oil. When the tank is filled the air valve outlet may be closed and the pressure in the tank may be built up to that required for feeding the oil into the furnace. Time for filling the tank is provided while heats are being poured or while the furnace is being charged. An example of how easily this measuring device operates in actual service is given in the following test. In starting the heat the gage read 12.5 inches and at the end of the heat the reading was 2.75 inches. The number of inches of oil used was, therefore, 9.75. Multiplied by the constant, 1.5, the volume of oil used becomes 14.625 gallons. In using the curve in Fig. 2 a horizontal line is traced from the point 9.75 at *I* and a vertical line is drawn from the point of intersection of the horizontal line on the diagonal line. The vertical line falls at *E* which corresponds to the 14.625.

The following is data for a typical day's run on one furnace:

Heat No.	Inches. Oil	Gallons. Oil	Brass melted. Pounds
To heat furnace in morning	6.00	9.00	...
First heat	10.00	15.00	625
Second heat	10.00	15.00	630
Third heat	9.50	14.25	629
Fourth heat	10.50	15.75	628
Fifth heat	9.75	14.375	630
Sixth heat	10.25	15.375	628
Seventh heat	11.00	16.50	627
Eighth heat	10.00	15.00	630
Blow out	3.00	4.50	...
		134.750	5,027

134.75 gallons fuel oil required to heat 5,027 pounds brass or 53.6 gallons fuel oil per ton brass melted.



BEARING CAP PATTERN FOR RUSH JOB

Time-Saving Kink for Rush Job

By M. E. Duggan

Patternmakers are called upon occasionally to prepare a pattern in an emergency, when a breakdown occurs and it is necessary to have a new piece made in the shortest time possible. In his haste, the patternmaker may decide upon a form of pattern which will save some time in the pattern shop, but which will cause an unnecessary expenditure of time in the foundry. To save delay, the patternmaker not only must consider the time required to make the pattern, but also the time consumed in making a mold from the pattern. This is particularly true when the patternmaker plans to save time by supplying the foundryman with sweeps instead of a pattern.

A pattern made for a large bearing cap is a good example of how one rush job was handled. Every piece of wood used in making this pattern was cut from a board dressed to 1 inch. The use of standard stock saved considerable time. The two end or binder pieces, *A* and *B*, were cut to the proper size. The filler pieces, *C* and *D*, were first cut to the correct length on the band saw and then cut to width on the rip saw. The pieces were assembled as shown in the accompanying illustration. Instead of being round, the inner and outer surfaces were made of flat sections leaving a wedged-shaped space between the filler pieces shown at *C*.

The natural tendency of patternmakers is to fill these spaces and reduce the irregular surface to a curved plane. This is unnecessary in an emergency, since the molder can fill the spaces with ordinary molding sand and smooth the surface with his slick. In this case the break occurred at 1:45 p. m. and the casting was completed at 4 p. m. The only tools which were used in making the pattern were the band and rip saws.

Do Grinding Wheels Actually Grind?

By Howard W Dunbar

IT HAS been a much debated question from the early use of the grinding wheel up to the present time as to just what occurs when the grinding wheel comes in contact with a piece of steel, cast iron or other hard material, and it probably will be surprising as well as interesting to know that the opinions of almost every one on this subject are correct to a greater or lesser degree.

In the early use of the grinding wheel and grinding machine the operation was nothing more than a polishing one, in which the material removed from the work was worn away by abrasion, friction, polishing, or whatever you may desire to call it. This fact was due to various reasons. Principally however, was the fact that the grinding machine was light, inexpensive and did not provide the proper support for the grinding wheel; and, too, the wheel in itself had not been developed to the high degree of refinement now usually found and always possible in a grinding wheel.

Even today, with good, heavy grinding machines, incorrect wheels, speed of work revolution or speed of wheel are used, which produce just as indifferent results as were always evident by the older methods. However, the reason for these indifferent results today cannot be charged to the grinding machine or grinding wheel, but rather to a lack of knowledge on the part of those responsible for such work for not selecting proper wheels or proper speeds to produce the best results.

Because of these facts, when some people say that grinding is nothing more than the rubbing away of material by abrasion they are correct; when others say that it is a polishing operation they are correct; and when still others say that it is a grinding operation which does not actually remove slivers of metal they are correct. By the ideal conditions, with the right wheel, right work speed, right type of machine, right kind of an operator, the grinding wheel actually cuts the metal and produces chips which resemble in shape and form chips produced by a lathe tool, only they are very much smaller and there are a great many more of them. These are the conditions which the grinding machine engineer always thinks of when speaking of the grinding operation. The object which should be constantly before every grinding operator is to make his wheel act in such a manner as to produce these little chips, because under these conditions the most metal is being removed, the greatest amount of work is being produced, and the machine and wheel are being used at their highest possible efficiency.

In the illustration accompanying this article is reproduced a photomicrograph of chips removed by a grinding wheel operated under the proper conditions.

It is possible with most wheels of average grain and grade to so regulate the work speed, wheel speeds and conditions of grinding as to make the wheel actually produce these little chips. The skill of the operator and his knowledge of the art of grinding play an important part in the amount of work produced and the results accomplished. Today with a wheel 2 inches wide of the grain size commonly used, there are approximately 1,171,000 little cutting particles coming in contact with the work every minute the wheel is revolved at the recommended speeds, and accordingly there is an equal number of little steel chips removed from the work in the same time. If this width of wheel is increased, more and more particles are caused to do their share of the work, and more and more chips will be produced when the wheel is used under correct conditions. It is for this reason alone that the wide wheel is used in cylindrical work.

PHOTOMICROGRAPH OF CHIPS FROM A GRINDING WHEEL

From *Grits and Grinds*, February, 1917. The author, Howard W. Dunbar, is with the Norton Grinding Co., Worcester, Mass.

THE FOUNDRY

A monthly journal devoted to all branches of the foundry trade

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Contents

How the Foundry Industry Has Prepared for War..... 171
History of Nickel Plating for Stove Decoration..... 175
Leaky Malleable Castings..... 175
Sensible Flask Equipment for Machine Molding..... 176
Electric-Arc Welding for Foundry Purposes..... 179
Chill Cracks in Lathe Beds..... 182
Systematic Pattern Storage Aids the Foundry..... 183
Experiments with Permanent Molds..... 187
Bethlehem Makes Large Iron Mold for Guns..... 188
Chilled Castings from a Cupola Running Gray Iron..... 188
Modern Methods of Melting Non-Ferrous Metals..... 189
Melting Brass in a Gas-Fired Cupola Furnace..... 189
Melting Practice at the Royal Mint..... 191
Ideals in Melting Metals..... 193
Gas as Fuel for Melting Alloys..... 193
Melting in a Crude-Oil Furnace..... 194
Electric Heating of Crucibles..... 194
What is Beryllium?..... 194
Problems of the Brass Founder..... 195
Porous Copper Castings..... 195
Melting Copper in Cupola..... 195
White Aluminum Alloy..... 196
Flux for Brass Particles..... 196
White Metal for Art Work..... 196
Lining for Melting Furnace..... 196
Magnalium Castings..... 196
Mixture to Hold Gasoline..... 196
Facings for Brass Castings..... 196
A Study of Inclusions of Alumina in Steel..... 197
Mixtures for Cylinders..... 202
Measuring Furnace Oil Without Using a Meter..... 202
Time-Saving Kink for Rush Job..... 203
Do Grinding Wheels Actually Grind?..... 203
Contents..... 204
A Problem for Foundrymen..... 204
Trade Outlook..... 204
Installing a Uniform Cost System in Foundries..... 206
What the Foundries are Doing..... 207
New Trade Publications..... 208

A Problem for Foundrymen

BEFORE many days manufacturers will be forced to realize that the war into which we have entered is to be taken seriously. The nation cannot fulfill its military duty satisfactorily without enlisting the aid of every industry, and the foundry will be called upon to play an important part. Foundrymen who today are willing to sit tight until necessity for action comes, will awake tomorrow to find that short-sightedness has greatly decreased their capacity for doing business for themselves or for the government. Wide-awake leaders in the foundry industry foresee the needs of the future and are making plans to be prepared. They realize, for instance, that the labor problems must be solved. The supply of foundry workers has never been sufficient in the past few years and with the tremendous demand for men in the military departments of the government and in the industries directly engaged in supplying and transporting war materials, there will be a further depletion in the ranks of foundry labor. If we are to profit from the experience of England and France we must take steps to preserve the organization of our foundries. To allow the indiscriminate withdrawal of men from the iron, steel and malleable casting plants of the country would be a mistake almost as disastrous as that which permitted the technically trained men of the allies to rush into the trenches at the first call in Europe. Enlistment from the industrial forces must be accomplished systematically, and according to a preconceived plan which carefully weighs the relative importance of military and industrial strength. The men engaged in the heavy work must be retained, but in the core room, light machine molding, offices, drafting rooms, etc., there is an opportunity to gradually replace men by women as the demand for men makes such action necessary. The problem of maintaining the efficiency of a smooth running foundry organization merits the attention of the leaders of the industry, and under no consideration should the country be allowed to suffer because the casting plants fail in producing their quota of war goods.

Trade Outlook

MUNITIONS work resulting from America's entrance into the war has had little effect upon the foundry industry except that foundrymen are forced harder than ever to meet the demand for castings. Slow deliveries of building materials have prevented many manufacturers from operating new foundries and additions to existing plants until long after the scheduled dates and enlistments coupled with the general scarcity of labor have caused foundrymen to wonder where they will secure men to operate the new units when they are completed. The prices of fuel and iron continue to soar and $50 iron is mentioned as a not-far-distant possibility. No. 2 foundry iron is quoted in the leading trade centers as follows: Pittsburgh, $40.95; Chicago, $39; Cleveland, $39; Buffalo, $45; Birmingham, $33; and Philadelphia, $41. Malleable pig iron is listed at $40.95, Pittsburgh; $39, Chicago, and $45, Buffalo. Lake Superior charcoal iron is selling at $40.25, Chicago. Spot foundry coke is quoted at $9.50 to $10; while coke for second half delivery sells at $8 to $9. Ferro-manganese is held at from $350 to $425.

Bureau of Standards Asks Alloy Information

The United States bureau of standards is making a compilation of the present state of knowledge and practice concerning the numerical values used by engineers and others for the properties of metals and alloys with a view of making generally available the most acceptable values of these constants and also for use as a basis of further experimental investigation. Blanks have been distributed among brass foundrymen, which are to be filled out, giving various chemical and physical properties of the metals or alloys and specific information is desired on the following:

Aluminum and its light alloys with zinc, copper, etc., of stated percentages; nickel, Monel metal and copper-nickel alloys; aluminum bronzes, such as aluminum 7 per cent and copper 93 per cent, and also aluminum 10 per cent and copper 90 per cent, etc.; manganese bronzes, both cast and wrought; phosphor bronzes, such as copper 80 per cent, tin 12 per cent, lead 7 per cent, and phosphorus 1 per cent; Muntz metal, naval brasses, Tobin bronze and brass containing 70 per cent copper and 30 per cent zinc, red and other brasses; bronzes containing copper 90 per cent, tin 10 per cent; copper 88 per cent, tin 10 per cent, zinc 2 per cent; copper 88 per cent, tin 8 per cent, zinc 4 per cent and other modifications with lead and iron added, etc., bearing metals, white metals and other alloys.

The following information is to be furnished to the bureau: Name of metal or alloy; state or condition, such as cast, annealed, hard-drawn, etc.; chemical composition and impurities; density; shrinkage coefficient; tensile strength, yield point and elastic limit in pounds per square inch; elongation in 2 inches, per cent; reduction of area, per cent; Brinell or scleroscope hardness; behavior in compression; frictional coefficient; abrasion resistance; melting range; coefficient of expansion; specific heat; thermal and electrical conductivity; resistance to corrosion; hydraulic properties, etc.

The United Compound Co., Buffalo, manufacturer of core wax and wax vent wire, will move into larger quarters at 228 Elk street, the same city.

The Sullivan Machinery Co., Ltd., has removed its office from Montreal to Toronto. Air compressors, hammer drills and spare parts are carried in stock.

The zinc-mining and zinc-melting industries experienced a year of prosperity in 1916. It is estimated that the recoverable zinc content of ore mined in the United States was 708,000 tons, compared with 605,915 tons in 1916 and 406,959 tons in 1914. The largest district gain was made by the Joplin region, which had an increase of over 40,000 tons.

Personals

Edward Salts, formerly connected with the foundry of the Jeffrey Mfg Co., Columbus, O., is now plant superintendent of the Lewis Foundry & Machine Co., Pittsburgh, with works at Groveton, Pa.

Louis Knapp has resigned as superintendent of the foundry department of the Haskell & Barker Car Co., Inc., Michigan City, Ind., to accept a similar position with the Chicago Malleable Castings Co., Chicago.

H. E. Dennie, formerly located at Salt Lake City, as representative of the Imperial Belting Co., Chicago, has been appointed western manager with headquarters at 525 Market street, San Francisco.

Charles Vickers, formerly associate editor of *The Foundry*, who has been connected with the Titanium Alloy Mfg. Co., Niagara Falls, N. Y., during the past four years, has severed his affiliation with that company.

J. W. Dopp, 1420 Dime Bank building, Detroit, formerly identified with the International Molding Machine Co., Chicago, as Michigan representative, is now handling the line of molding machines and foundry equipment manufactured by Henry E. Pridmore, Chicago.

Oil Residue as a Cupola Fuel

The coke shortage, which has been unusually acute, has compelled foundrymen to resort to many expedients to get out their heats and in addition to the free use of bituminous coal charged with coke in cupolas, many foundrymen have experimented with a crude oil residue which has given unusual results. This residue contains approximately 99 per cent carbon and since it is unusually low in sulphur, 0.025 per cent, it makes an exceedingly desirable fuel for cupola operations. It has been found that owing to the intense heat generated by this residue, the metal becomes unusually hot. It is necessary to charge it with coke, since it will not carry the burden of a cupola charge when used alone. In the extreme west, where coke is unusually high in price, this crude oil residue has been used successfully in foundries for several years.

Pattern Lumber Selection

By E. L. Watson

In the March issue of *The Foundry* an interesting article was published on "The Selection of Pattern Lumber." No one more appreciates the importance of good pattern lumber, even if it is used merely for a master pattern, than the man in charge of the pattern shop. About a year ago I stopped ordering pattern lumber. This was due to the fact that a carload of clear white pine would contain soft and hard lumber, some gummy, some coarse-grained and some fine in grain. The lumber dealer who received the order seemed to consider white pine without knots satisfactory pattern lumber and sent it along. We buy white pine flask lumber in carload lots and I select a sufficient amount of lumber from this to serve my purpose. When the car is delivered I take my pick of the lot and always get No. 1 material. I pick out the close-grained boards with the black knots, which are sent away to dry thoroughly before use. This lumber is particularly desirable for turning large thin shell patterns requiring a soft, sound, even-tempered quality. Also, it is fine for carving. One can always work it up economically with little more waste than clear material and it is pattern lumber in every sense. The saving to the company is large and the economy effected in the pattern shop is considerable.

Trade Notes

Scovell, Wellington & Co., Boston, certified public accountants and industrial engineers, have established a Cleveland office in the Illuminating building under the direction of H. L. Green, resident manager, and V. D. Bierman, associate manager.

The Hoopes Combustion Engineering Corporation, Glens Falls, N. Y., is installing an electric furnace for the manufacture of steel castings. A large extension to the foundry is being built for this department.

The Chicago office of T. P. Kelly & Co., New York, manufacturers of foundry facings and supplies, has been removed to the Boylston building, 333 South Dearborn street. A larger warehouse also has been acquired for the stock of foundry supplies carried by this company in the central west.

The Julius King Optical Co., New York, has been awarded the Louis Livingston Seaman medal for the year 1916 by the American Museum of Safety. This medal was awarded for "progress and achievement in the promotion of hygiene and the mitiga-

tion of occupational disease". This award was based on the Julius King Optical Co.'s efforts in the production of a scientifically correct color scheme for lenses in goggles worn by workmen exposed to the intense glare of arc welding and other metallurgical operations.

Test of Crucible

It is said that 70 consecutive heats of brass were poured from a new type of crucible recently developed by the Lava Crucible Co., Zelienople, Pa., during a recent test in charge of F. T. Aschman, professor of chemistry, University of Pittsburgh. The test, conducted April 13-15, was witnessed by a number of brass and crucible steel manufacturers in the Pittsburgh district.

The analysis of the metal used was: Copper, 68.17 per cent; zinc, 30.16 per cent; iron, 1.05 per cent; lead, 0.11 per cent, and oxygen, 0.35 per cent. The average weight of the metal charged into a commercial No. 60 crucible was 89 pounds. The crucible lost four pounds in weight during the test and weighed 31 pounds after the seventieth heat was poured.

The crucible of the Lava company was developed by Louis DeBats, superintendent of the plant. Since importations of German clay have been shut off by the war, it is interesting to note that the Lava crucible is made entirely from domestic products including graphite, clay, carborundum and binding materials. The company has completed plans for increasing the capacity of its plant to 2,000 crucibles a week. Officers of the company, which has offices in the First National Bank building, Pittsburgh, are: President, M. E. Moffett; vice president, M. W. Ray; secretary and treasurer, P. L. Berkey.

STEEL REINFORCED LEATHER HANDPAD

A Serviceable Handpad

Owing to the growing scarcity of heavy canvas, old belting and other second-hand materials which were formerly used in making handpads, there has been an increased demand for a scientific and serviceable handpad for use in foundries. A handpad of heavy-weight chrome tanned leather reinforced with steel lacings has recently been developed by the Hickory Steel Grip Glove Co., Chicago. A strap and buckle form the adjustment about the wrist, while a leather strap attaches the pad to the top of the hand. As shown in the accompanying illustration, the fingers are left free for use, thus making the pad especially adapted for working with sheet metal. When the hand is closed, the entire palm and fingers are protected.

Installing a Uniform Cost System in Foundries

TO PROMOTE the adoption of a uniform system of foundry cost accounting among its members, the American Foundrymen's Association has outlined a plan of procedure which represents the most comprehensive effort in this line of endeavor that has ever been undertaken by a co-operative body. For many years this organization has had cost committees at work which have presented valuable reports at the annual meetings of this society, but unfortunately a large part of this work has been without practical results owing to the fact that the members, in only few instances, have followed the recommendations made.

To make this work more practical and to facilitate the installation of uniform cost-keeping methods in the plants of the members of this association, it has been decided to provide them with the personal service of a cost expert whose duty it will be to make their existing cost systems conform to the one that is to be adopted. Without the services of a cost accountant to introduce the system, no headway can be made toward uniformity of practice, which is the underlying basis for intelligent estimating among competing companies. Since the American Foundrymen's Association, due to its low cost of membership, is without means to carry on this special work, it was decided to raise a fund by subscription among those who desire to participate in the benefits to be derived from this undertaking. The plan will enable foundrymen to obtain a cost accounting system at a nominal cost, which will be representative of the latest and best practice in cost-keeping methods.

Cost is Nominal

Productive labor is a good measure of the value of the business transacted by a foundry and, therefore, the expense of this undertaking will be pro-rated on the basis of the number of molders and coremakers employed. The schedule of charges that will apply follow: Foundries employing up to 40 molders and coremakers, $50; from 40 to 200 molders and coremakers, $1.25 for each molder and coremaker employed; for plants employing more than 200 molders and coremakers a flat charge of $250 will be made. Since additional traveling expense will be involved in the installation of the system outside of the industrial centers of the United States and Canada, an extra charge will be made for this service west of the Mississippi river, south of the Ohio river and outside of the Province of Ontario, in Canada.

Payments are to be made on the following basis: Twenty-five per cent when subscribing to this special fund; 25 per cent upon the receipt of the book containing the uniform cost system; 25 per cent after the system has been installed by the cost expert and the remaining 25 per cent after the subscriber has received from the cost accountant a written report covering the system in use, with suggestions to make it conform to the uniform method to be adopted.

To carry on this work, the cost committee of the American Foundrymen's Association has engaged the services of C. E. Knoeppel & Co., New York, industrial engineers and cost accountants. Data are now being gathered preparatory to the compilation of a uniform system of cost-keeping for foundries which can be adapted to shops specializing in the manufacture of gray or malleable iron, or steel castings. The problems of the foundry which is a department of a manufacturing plant and produces no castings for the trade will

be considered and provision also will be made for specialty, light and heavy work shops.

When the uniform cost system has been ratified by the cost committee, it will be printed in pamphlet form and will be distributed among all of the subscribers. As soon as possible thereafter, cost experts in the employ of C. E. Knoeppel & Co. will visit each one of the plants of the subscribers and will point out the features of the cost system and will aid in its installation. This personal visit will be followed by a written report by the cost expert who will detail every step to be followed in the introduction and use of this system. For a reasonable time thereafter, the advice of C. E. Knoeppel & Co. can be had by correspondence without additional cost to any of the subscribers.

Subscribers Must Be Members

Subscribers to this fund are limited to the membership of the American Foundrymen's Association, but foundries not so enrolled can derive the benefit of this great work by becoming members of this organization.

Furthermore, only subscribers to this special fund will receive a copy of the uniform cost system and the services of C. E. Knoeppel & Co., membership in the American Foundrymen's Association alone not entitling those so enrolled to participate in the cost accounting work.

Favorable replies already have been received from 217 members of this organization in the United States and Canada, and 51 have forwarded their subscriptions. This is sufficient assurance that the plan can be carried to a successful conclusion and it marks the beginning of the greatest uniform cost campaign ever undertaken in a single industry.

The members of the cost committee who conceived this undertaking follow: B. D. Fuller, chairman, Westinghouse Electric & Mfg. Co., Cleveland; H. J. Koch, Fort Pitt Steel Casting Co., McKeesport, Pa., J. Roy Tanner, Pittsburgh Valve Foundry & Construction Co., Pittsburgh; C. R. Messinger, Sivyer Steel Casting Co., Milwaukee, and A. O. Backert, secretary, Twelfth and Chestnut streets, Cleveland.

The McGraw and Hill publishing companies, New York, have been consolidated under the corporate name of the McGraw-Hill Publishing Co., Inc., which has acquired all of the properties and interests of the two constituents, including the following technical journals: *Electrical World, Electrical Railway Journal, Electrical Merchandising, Engineering Record, Metallurgical and Chemical Engineering, The Contractor, American Machinist, Power, Engineering News, Engineering and Mining Journal* and *Coal Age. The Engineering News* and *The Engineering Record* have been consolidated under the name *"Engineering News-Record"*, with Charles Whiting Baker, former editor of *Engineering News*, as editor-in-chief. James H. McGraw is the president of the new company, Arthur J. Baldwin, president of the Hill Publishing Co., vice president and treasurer and E. J. Mehren, vice president and general manager.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

The Sav-A-Life Fender Co., Ashtabula, O., contemplates the erection of a foundry.

The Hammer-Bray Co., Center street, Oakland, Cal., will erect a one-story foundry.

The Dearborn Foundry Co., Chicago, has been incorporated with $10,000 capital, by C. E. Fargo, D. D. English and L. B. Fargo.

The Weatherly Foundry & Machine Co., Weatherly, Pa., will make extensions to its plant.

The McCairns Foundry Co., Connellsville, Pa., will build a one-story, 60 x 65-foot foundry addition at a cost of $10,000.

Edgar T. Ward & Sons, Boston, have purchased a site on Old Colony avenue for a foundry.

The Smith Gas Engine Co., Dayton, O., contemplates erecting a two-story office building, a foundry and a machine shop.

A one-story addition, to cost $20,000, will be erected to the plant of the Stevens Foundry & Machine Co., New Orleans.

The Elmira Transmission Co., Elmira, Ont., Can., will build dry kilns, a foundry and a machine shop.

Contracts have been awarded for the erection of a large addition to the plant of the Osborne Casting Co., Racine, Wis.

The Industrial Machine Co., Pottstown, Pa., contemplates the erection of a foundry, 50 x 130 feet.

A contract has been awarded for a 60 x 100-foot foundry to be erected by the Turner-Fricke Gas Engine Co., Sharon, Pa.

The Singer Mfg. Co., Elizabeth, N. J., will build a one-story foundry, 200 feet square, at a cost of $60,000.

A $12,000 foundry will be erected on Cherry street, Toronto, Ont., for the Queen City Foundry Co.

The Davis Mfg. Co., Milwaukee, will build a foundry, 150 x 300 feet, of brick, steel and concrete construction.

The Syracuse Malleable Iron Works, Syracuse, N. Y., has awarded the contract for a $15,000, 87 x 183-foot addition to its foundry.

The Pennsylvania lines west will build a 1-story, 50 x 50-foot addition to its brass foundry at Allegheny, Pa.

The Spramotor Co., London, Ont., Can., will build a foundry and machine shop at St. Thomas, Ont., at a cost of $100,000.

The Ohio Steel Foundry Co., Lima, O., has purchased the Blackwood Steel Foundry Co., Springfield, O., and will continue to operate it.

The Whitehead & Kales Iron Works, Detroit, will build a foundry and machine shop, 74 x 272 and 62 x 112 feet, respectively.

Plans have been prepared for the erection of a 72 x 100-foot addition to the foundry of the Independent Stove Co., Owosso, Mich.

The Wisconsin Farm Implement Co., Beloit, Wis., contemplates the erection of a 40 x 75-foot addition to its foundry.

The Joseph Pedrick Foundry Co., Camden, N. J., will build a 75 x 78-foot plant for the manufacture of cast iron boilers.

The Louisville Car & Foundry Co., Louisville, Ky., has been incorporated with a capital stock of $10,900 by C. H., Henry and Charles Schimpeler.

The Edgewater Foundry Co., Edgewater, N. J., has been incorporated with $10,000 capital, by Joseph Fuchs, F. Butzhah and A. W. Brain.

The Montrose Improvement Co., Thirteenth and Berry streets, Brooklyn, will build a foundry of brick and steel construction, one and two stories, 80 x 180 feet.

Plans are being prepared for a foundry and other additions to the plant of the Rock Island Mfg. Co., Rock Island, Ill., which will cost $30,000.

The Vancouver Engineering Works, Vancouver, B. C., Can., has been incorporated to conduct a general foundry and machine shop business with $1,000,000 capital.

C. S. Brown, Fred Bizzantz, J. M. Morgan, Carl C. Kesler and W. J. Richie have incorporated the Chalmers Mfg. Co., Lima, O., with a capital stock of $60,000. A foundry will be operated.

The Flockhart Ring Casting Co., Newark, N. J., has been incorporated to engage in the manufacture of piston rings with $30,000 capital, by James Flockhart, D. Sensano and others.

The Blewett Harvester Co., Pendleton, Ore., plans the erection of a foundry. The Walker Foundry & Machine Co., Braddock, Pa., will build a foundry addition, 36 x 40 feet and a machine shop, 124 x 166 feet.

The Aetna Foundry & Machine Co., Warren, O., has been taken over by W. W. Woodruff, of the Jeffery Mfg. Co.; Robert L. McCarroll, of the United Coal Co., and J. McClain, of the McClain Mining Co., all of

Pittsburgh. The plant will continue to make castings and tin plate machinery and will be enlarged shortly.

The Cleveland Aluminum Castings Co., 1386 East Fortieth street, Cleveland, has purchased a site, 50 x 140 feet, adjoining its present property, on which it will build an aluminum foundry.

The Indianapolis Castings Co., Indianapolis, has been incorporated to take over the Indianapolis Foundry Co. The new company is capitalized at $175,000 by Frank W. Lewis, Charles O. Roember and John Wallace.

The Bradley Machine Co., Middletown, N. Y., has been incorporated to operate a foundry and machine shop. The company is capitalized at $107,500 by E. N. Oakes, J. M. Bright and T. Watts, 4 East Main street.

The Columbia Malleable Casting Co., New York City, has been incorporated with $50,000 capital. F. F. Gearn, W. F. Wood and F. M. Clute, 100 Broadway, New York, are the incorporators.

The B. C. Co., Revere, Mass., has been incorporated to engage in the foundry business with a capital stock of $5,000. Henry A. Buzzell is president and Edward H. Tibbets, treasurer.

H. Kramer, 720 South Canal street, Chicago, will build a foundry, 75 x 125 feet; a warehouse, 75 x 125 feet and a crushing room, 40 x 75 feet. The estimated cost is $60,000.

Thomas J. Finn, Waterbury, Conn., will erect a $50,000 iron foundry on a site which he recently purchased at Worcester, Mass. The plant will probably be operated under the name of the Worcester Foundry Co.

The Tristate Foundry & Machine Co., Wellsburg, W. Va., has been incorporated with a capital stock of $50,000. The incorporators are M. J. Konold, E. D. Mason, E. A. Johnson, E. R. Wendemuth, Pittsburgh, and Alex McInnes, Wellsburg, W. Va.

E. G. Bosworth and C. E. Ard have organized the Bosworth-Ard Machine & Foundry Co. and will remodel the plant of Stickney & Levi, Anniston, Ala., into a general foundry and machine shop for the manufacture of gray iron, semi-steel and brass castings.

The Aluminum Goods Mfg. Co., Manitowoc, Wis., will erect a new plant at Newark, N. J., which will cost approximately $350,000. The building will be six stories high, 75 x 375 feet, of reinforced concrete, steel and brick construction.

The name of the Southern Illinois Machine & Foundry Co., Murphysboro, Ill., has been changed to the Egyptian Iron Works. The company contemplates the erection of a foundry and car shop for the manufacture of mining cars and other mining equipment.

J. H. McNary, formerly general superintendent of the Magee Furnace Co., Taunton, Mass., will erect a foundry, two stories high and 60 feet in length, at Chelsea, Mass. He has purchased the business of the Dighton Furnace Co., Dighton, Mass., and will remove it to the new plant when completed.

The James A. Brady Foundry Co., Chicago, has purchased a site, 266 x 449 feet, at Forty-fifth street and Western avenue. The company will erect a new plant, including a foundry and office building, 150 x 360 feet and a cleaning building, 90 x 135 feet. The estimated cost of the plant is $300,000.

Emil Mueller, formerly manager of the Cedar Grove Foundry Co., Cedar Grove, Wis., has organized the Mueller Foundry Co., of Cedarburg, Wis. with a capital stock of $6,000. The company will operate the former plant of the Cedarburg Foundry Co., now owned by John Lauterbach, who, with Oscar J. Hurth are the owners of the new concern. The Cedarburg foundry was idle for some time until early last fall, when it was leased by outside interests and operated only a few months.

The Pyott Co., 955 Carroll avenue, Chicago, manufacturer of cast iron pulleys, has purchased the plant of the W. A. Jones Foundry & Machine Co., North avenue and Noble street, Chicago, including a machine shop, power house, foundry and other buildings. The site embraces about 65,000 square feet of ground.

The capital stock of the National Steel Casting Co., New Cumberland, W. Va., has been increased from $100,000 to $300,000 and it has been decided to install an additional 25-ton basic open-hearth furnace. At present one unit of this size is in operation. This company manufactures castings for rolling mill and railroad work and also does an extensive jobbing business.

The Lipman Car & Refrigerator Co., Beloit, Wis., manufacturer of refrigerating units for railroad cars, will erect a plant having a capacity for equipping 12,000 cars annually. The plant will include five buildings, 40 x 250 feet, with double tracks; two buildings, 60 x 300 feet, a foundry, machine shop, wood and sheet metal-working shops and other structures.

Negotiations are under way for the location of a malleable iron foundry at Louisville, Ky. Tampton Aubuchon, general manager of the Louisville Industrial Foundation, is endeavoring to interest manufacturers of malleable iron in the location of a plant at Louisville and if this is not successful, local capital will be employed to develop the industry.

NEW TRADE PUBLICATIONS

DRILLING MACHINES. — The Langelier Manufacturing Co., Providence, R. I., is distributing an eight-page folder devoted to belt-driven ball-bearing drilling machines. Each type of machine is illustrated and described by complete specifications. The standard equipment of these machines includes foot feed in addition to hand feed. One belt and one hole depth gage is shipped with each machine. In the two spindle type drill each spindle may be run or stopped independently of the other. The drills are equipped with automatic oil feed with foot controlled automatic shut-off.

BELT-DRIVEN ALTERNATORS. — An eight-page bulletin, issued by the General Electric Co., Schenectady, N. Y., is devoted to belt-driven alternators, built in sizes from 30 to 240 kilowatts. These generators are designed for both power and lighting service and can be furnished with either direct-connected or belted exciters. All pole pieces are punched to receive a squirrel cage winding, so that at any future time the machine can be changed to a synchronous motor or synchronous condenser by the simple addition of this winding, which can be assembled readily by any station operator. Detailed views of the machine are included, with tables showing complete ratings.

PNEUMATIC TOOLS. — The Independent Pneumatic Tool Co., Chicago, recently issued a catalog devoted to the company's complete line of pneumatic tools and electric drills. It is said that piston air drills are now equipped with pressed vanadium steel connecting rods and pistons. Concise descriptions accompany the illustration of each tool and each individual part. In the electric drills the windings are all enclosed; the countershaft and spindle are supported on roller bearings as they run at a slower speed. The large size drills have large bronze plain bearings at the lower end of the spindles. This construction provides for side thrusts placed upon them by the forcing of the drills or reamers through the work.

CORKBOARD ISOLATION. — A comprehensive booklet devoted to a description of the use and application of corkboard as a sound deadener was recently issued by the Armstrong Cork & Insulation Co., Pittsburgh. Noise and vibrations have long been recognized as undesirable but little has been done in past years with the object of reducing or eliminating them except in hospitals, hotels, etc. Noise is the direct result of vibrations and in consequence can only be eliminated in the same proportion as the vibrations are eliminated. There are two ways, according to the Armstrong company, in which this may be accomplished: First, by anchoring the machine to a foundation too massive to be set in motion by the vibrations generated by its operation; second, by isolating the machinery—that is by placing it upon a material of such structure that the vibrations will not readily pass through it, but will be absorbed. Corkboard is said to fulfill the requirements of the alternative.

HAND TRAVELING CRANES. — The Brown Hoisting Machinery Co., Cleveland, has issued a catalog containing 36 pages, which is devoted to overhead hand traveling cranes. Its construction permits it to be used in very limited head room and it consists of a single I-beam supported at each end on a cast steel truck frame. The I-beam is of standard size, the lower flange serving as a track for the trolley with the load. The truck frame is a single steel casting of light construction with ample strength for the crane capacity. The I-beam rests on two planed surfaces at the center of the truck frame, being bolted to the truck frame at the top and also is held in place by a dowel on the truck frame which fits into a small recess on the bottom side of the small flange of the I-beam. The truck frame is supported on two truck wheels with a bearing on each side of the wheel. All standard cranes from one-fourth to one ton capacity inclusive, with spans not exceeding 11 feet, have no traveling mechanism. These cranes, however, are propelled easily along the track by pushing or pulling on the load. The larger capacity cranes are equipped with hand-traveling chain and sprocket wheel. By pulling on the hand chain the crane is propelled along the runway. The largest capacity cranes are fitted with traveling gears which reduce the amount of pull required on the hand-traveling chain necessary to travel the crane. Also, the cranes can be equipped with a travel motor for propelling it along the track, being controlled from the floor by means of pendant cords. The catalog contains a list of prices of cranes of various sizes, details of their construction and a large number of installation views showing the application of these cranes to foundry and industrial plant operations.